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KOREA

STAFF APPRAISAL REPORT

GOJEONG POWER PROJECT

November 20, 1979

Projects Department
East Asia and Pacific Regional Office

CURRENCY EQUIVALENTS

US$1.00	=	Won (W) 485
W 1,000	=	US$2.06
US$1 million	=	W 0.485 billion
W 1 million	=	US$ 2,062

UNITS AND EQUIVALENTS

1 meter (m)	=	3.28 feet (ft) = 100 centimeters (cm)
1 kilometer (km)	=	0.62 miles (mi)
1 hectare (ha)	=	2.47 acres
1 square kilometer (sq km)	=	0.38 square mile (sq mi)
1 cubic meter (cu m)	=	35.315 cubic feet (cu ft)
1 cubic meter per minute (cu m/min)	=	264.2 gallons per minute
1 kilogram (kg)	=	2.206 pounds (lb)
1 ton (metric) (t = 1,000 kg)	=	1.100 short tons (sh.tons)
1 kilowatt (kW)	=	1,000 Watts (10^3 W)
1 Megawatt (MW)	=	1,000 kW (10^3 kW)
1 Gigawatt (GW)	=	1,000 MW (10^6kW)
1 kilowatt-hour (kWh)	=	1,000 Watt-hours
1 Gigawatt-hour (GWh)	=	1,000 Megawatt-hours (10^6kWh)
1 kilocalorie (kcal)	=	3.968 British thermal units (Btu)
1 atmosphere (atm)	=	14.70 pounds per sq inch = 1.033 kg/sq cm

GLOSSARY OF ABBREVIATIONS

MER	-	Ministry of Energy and Resources
MOF	-	Ministry of Finance
MOC	-	Ministry of Construction
MOST	-	Ministry of Science and Technology
EPB	-	Economic Planning Board
KDI	-	Korea Development Institute
KECO	-	Korea Electric Company
ISWACO	-	Industrial Sites and Water Resources Development Corporation
EDF	-	Electricite de France
KVA	-	Kilovolt-ampere
°C	-	Degree centigrade
SWU	-	Separative Work Units

Fiscal Year = Calendar Year

KOREA

KOREA ELECTRIC COMPANY

GOJEONG POWER PROJECT

Table of Contents

TABLE OF CONTENTS

LIST OF ANNEXES

CHARTS

This report was prepared by Messrs. J.A. Cavallotti and P. A. Cordukes on the basis of an appraisal conducted in June 1979.

KOREA

GOJEONG POWER PROJECT

1. THE POWER SECTOR

Energy Resources

1.01 Korea's indigenous commercial energy resources are very limited and are principally confined to hydroelectric power and coal. Economically exploitable hydroelectric resources have been put at some 2,000 MW, of which about 35% (712 MW) is now being utilized. The Government plans to build a further 743 MW of hydroelectric capacity by 1986 through multipurpose projects. By then, about 73% of Korea's hydroelectric potential would have been developed. Proven workable reserves of low grade coal (average 4,600 Kcal/kg) are estimated at about 600 million tons, of which some 400 million tons could be exploited, equivalent to about 23 years supply at present production.

1.02 Coal production reached 17.2 million tons in 1977, of which 73.2% was produced by the private sector. The greater part (88%) of this production is used to manufacture "briquets" which are very widely used domestically for cooking and space heating. The remainder goes to heavy industry with very little domestic coal being used in the electricity sector. Present coal production does not meet internal demand (some 800,000 tons of coal were imported in 1978). According to the consultants who recently made a review of Korea's energy sector /1, 1983 would be a critical year since briquet demand for the residential sector could be over 20 million tons while the local production available for briquets might be only 16 million tons. The gap between demand and supply would persist thereafter.

1.03 In view of the rising production cost the Government increased in April 1979 the price of domestic anthracite by 35% from US$24.5 per ton to US$33 per ton. Although this price is approximately 39% higher than the imported bituminous coal used in the power plants for the same equivalent heat value, it is still cheaper than kerosene or other alternative fuel for domestic purposes.

1.04 Consumption of primary energy has kept pace with overall economic expansion between 1961 and 1977 and grew at an annual average rate of 9.0%, although during 1974 and 1975 annual energy growth was only 0.1% and 6.2% respectively, because of the oil crisis at the end of 1973, which affected Korea's economic development though only temporarily. During 1961-1977 the GNP per capita grew by an average rate of 9.8% a year with a GNP elasticity of energy demand of 0.92.

/1 UNDP/IBRD Korea Energy Policy Study, (Annex 1).

1.05 Although the industrial sector is the largest energy user, about one third of the sector's use of energy goes to electricity. Electricity is the fastest growing form of energy in Korea; its share in total energy demand has risen from about 6% in 1961 to 20% in 1977 and is expected to reach some 30% by the year 2000. Energy consumption by each type of fuel and sector is shown below:

Energy Consumption by Fuel

	1961		1971		1977		Growth rate
	10^{12} Kcal	%	10^{12} Kcal	%	10^{12} Kcal	%	%-Year
Oil	8	9.1	115	54.8	220	63.6	23.1
Coal	28	32.2	56	26.4	96	27.8	8.0
Hydropower/a	2	1.8	3	1.6	2	0.7	2.6
Total Commercial Energy	38	43.1	174	82.8	318	92.0	14.2
Wood and Charcoal	50	56.9	36	17.3	28	8.0	-3.7
Total Energy	88	100.0	210	100.0	346	100.0	9.0

/a Figures have been rounded.

Energy Consumption by Sector

	1961		1971		1977		Growth rate
	10^{12} Kcal	%	10^{12} Kcal	%	10^{12} Kcal	%	%-Year
Industry	13	14.8	64	30.5	153	44.2	16.7
Transportation	5	5.7	21	10.0	34	9.8	12.7
Residential	57	64.8	71	33.8	94	27.2	3.2
Commercial	5	5.7	26	12.4	33	9.5	12.5
Other	8	9.0	28	13.3	32	9.3	9.1
Total	88	100.0	210	100.0	346	100.0	9.0

1.06 Projections prepared by the Ministry of Energy and Resources (MER) in February 1979 show that the energy demand would be some 2,781 x 10^{12} Kcal (eight-fold the energy demand in 1977) by year 2000 assuming that the average annual GNP growth would be 9.25% and the increase in energy demand would be 9.7% a year. The Government's objective in the long-term is to diversify the origin of energy imports to lessen the risk of loss of supply through failure to maintain continuity of fuel supplies. This is aimed to reduce the present heavy dependence on imported oil (64% in 1977) by switching to imported coal and uranium, so that by the year 2000 the share of oil would be around 43%, nuclear power 23%, gas 10% and coal 21% of energy demand.

1.07 This forecast appears to be optimistic since the government decided last June to take measures in order to reduce the actual rate of economic growth, at least for the next few years. It did so in view of the impact of higher oil prices on world energy trade and the new import restrictions adopted by many of the major industrial countries as a consequence of the slowdown in the world economy. The Government has also launched an energy conservation program aimed at reducing overall energy consumption by 5% from 1979 and has created a special fund for rational use of energy of W 4.0 billion for 1979 and of W 10 billion for 1980 to encourage private industries to modify their energy consumption patterns to more energy efficient forms. The program also includes special inspection teams to conduct surveys of 900 industrial firms to seek possibilities of saving oil and oil products. In the power sector the major measures for saving energy include higher monthly rates for residential and commercial consumption above 300 kWh; prohibition on air conditioning except between July 10 and August 20 and electrical signs for outdoor advertisement (para. 3.07). Application of a long-run marginal pricing system would also be advisable to induce energy saving in the energy sector.

1.08 If the present nuclear program is carried out, the estimated requirement for natural uranium will reach the level of 15,000 tons of U_3O_8 per year by year 2000 and the annual requirement for enrichment service will be close to 6,000 tons of SWU./1 Since Korea has only low-grade uranium ore and the presently known uranium reserves in the country are about 3,000 tons (only sufficient for three units during its useful life), Korea will largely have to depend on long-term foreign contracts for uranium supply, enrichment services, etc. KECO is now engaged with Taipower Co. (Rep. of China) and ANSCHUT (USA) in a joint venture for uranium exploration in Paraguay.

1.09 Korea's dependence on imported energy was nearly 68% of all energy consumed in 1977 and could reach some 85% by year 2000. Accordingly, a periodic review of energy demand and supply patterns appears to be advisable to ensure that it matches the expected economic development of the country at least cost. The Government is expected to carry out these reviews.

Sector Organization

1.10 The Ministry of Energy and Resources (MER), created at the beginning of 1978, is responsible for the overall coordination of the energy sector. Through its Electricity Bureau, MER formulates the national policy for electricity generation, transmission and distribution, and oversees and controls the activities of KECO, approving its future plans and recommending electricity rates to the Government. MER shares with the Economic Planning Board (EPB) and the Ministry of Finance (MOF) the responsibility for defining investment priorities and approving KECO's annual budget. The Ministry of Construction (MOC) retains jurisdiction over the survey, exploration,

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/1 UNDP/IBRD Korea Energy Policy Study.

development and use of water resorces throughout the country. Lastly, the Ministry of Science and Technology (MOST) is responsible for the licensing, regulation and supervision of the nuclear industry, although KECO is responsible for the design, equipping, construction and operation of the nuclear power plants.

1.11 KECO is the only public electricity distributor in Korea, and it owns all the generating facilities, with the exception of a 325-MW steam thermoelectric plant owned by the Kyongin Energy Company, a private oil refinery, and the multipurpose hydro facilities owned by the Industrial Sites and Water Resources Development Corporation (ISWACO), a government agency, which at present has an installed capacity of 200 MW (Soyanggang multipurpose project). The electricity generated by these two companies is sold in bulk to KECO.

1.12 KECO is the country's largest public corporation. The Government owns 82% of its share capital and it should be fully government-owned by 1981. KECO is a bureaucratic organization and suffers from excessive governmental regulations and controls. Several of its functions, such as establishing wage and salary levels and the number of its employees, are decided by the Government. There has been an excessive turnover of experienced personnel because of inadequate incentives and more attractive opportunities in the private sector. KECO also plays a very small part in preparing the studies for demand forecasts and for the expansion program. These studies, which should be conducted by KECO, have recently been assigned to the Korean Development Institute (KDI).

1.13 Since its formation in 1961, KECO's basic function has been to meet the growing demand for electric power. As a result, the company's growth has been based almost solely on its original structures, so that today some of its operating procedures are not the best suited to accomplish its medium-term objective with efficiency and economy, particularly considering that the present demand of 5,118 MW (1978) will almost triple over the next 8 years (by 1986). To meet this situation, the Government requested KDI in 1978 to conduct a study for the reorganization of KECO (para. 2.03). Although the Government intends to support the necessary reinforcement of KECO's organizational structure to keep pace with its growth and the sector's needs over the next ten years, it will probably not implement the necessary changes until it has fully taken over that part of KECO's share capital that is still in private hands.

Bank Role and Sector Lending Strategy

1.14 Though the Bank has not made any direct loan to the electricity sector in Korea it has assisted the sector in several other ways. Kyongu Tourism Project, Loan 953-KO for US$25.0 million made in 1973, included an electricity component of US$3.7 million for transmission and distribution facilities in the resort area. Loans 1216-KO and 1218T-KO for US$60 million, made in 1976 for a rural infrastructure project included a US$18.1 million component to assist with the electrification of some 300,000 rural housing units, which benefitted about 1.7 million people. Also Loan 1666-KO, made to ISWACO in March 1979 for US$125 million to finance part of the Chungju multipurpose project included a 460-MW electricity component.

In addition, the Bank reviewed the electricity sector in 1975, and its economic report, of February 1977, provided an overview of the energy sector and made a number of recommendations for stimulating and rationalizing the electricity sector, some of which have been implemented by the Government. The Bank is also acting as executing agency for a UNDP study, assisting the Government in drawing up a long-term energy policy. The final draft of the study is currently being examined by the Government. The consultants' recommendations are summarized in Annex 1.

1.15 By participating in the proposed loan for the Gojeong project, the Bank intends to help the Government and KECO in the rationalization process, with a view to optimizing the allocation of resources to the electricity sector, which because of its magnitude represents approximately 14.3% of public expenditure and accounts for almost 1.4% of GNP. The Bank will also encourage the Government to bring electricity prices gradually into line with actual costs for the different consumer categories so as to prevent improper use of the service and assure KECO of sufficient revenues to enable it to make a reasonable financial contribution to the expansion of the electricity system.

1.16 Institution building and helping KECO achieve operational autonomy will be another important objective of the proposed loan. KECO will prepare studies, relative to changes in its organizational structure, designed to improve its operations and strengthen its basic units such as the planning departments, enabling them to perform their functions properly. Gradual elimination of the constraints preventing KECO and the entire electricity sector from developing is a matter requiring urgent attention. It is expected that these points will be addressed in a study of KECO's management and organization which would be financed under the proposed loan (para. 2.04).

Power Market and Supply

1.17 The average annual rate of increase in Korea's electricity generation over the period 1961-78 was 18.5%, with GDP elasticity of 1.9. Present per capita consumption is 733 kWh, which is higher than average for Asia. Installed capacity at the end of 1978 was 7,464 MW, including 548 MW accounted for by auto-producers. Thermal facilities accounted for 80.5% of total electricity generation.

1.18 Korea has around 5 million subscribers in an estimated total population of 37 million. Ninety seven percent of these subscribers are residential and electricity service is available to 97.2% of the population./1 Consumption by large industry represented 66.4% of total consumption in 1978, followed by small industry as shown below:

/1 Practically 100% of total urban population and 95.3% of the rural population.

	1978			
	Sales		Subscribers	
	GWh	%	No.	%
Lighting	3,959	14.5	4,779,259	96.8
Small power	5,061	18.5	132,998	2.7
Large power	18,116	66.4	10,580	0.2
Agricultural	190	0.6	12,318	0.3
Total	27,326	100.0	4,935,155	100.0

The labor force in the sector totaled 16,800 at the end of 1978, with a ratio of 444 KW/ employee and 294 consumers/employee, which is considered satisfactory.

Rural Electrification

1.19 The rural electrification program, designed to improve the living conditions of the rural and fishing population, was started in 1965 following enactment of the law. The program provides for the electrification of 2,834 thousand housing units. By the end of 1978, about 2,755 thousand of these had been connected to the electricity supply system, leaving only 79,000 throughout the country (without electrification), most of these being scattered among the islands or located in remote mainland areas not yet reached by the system. KECO estimates that the program will be completed in 1981. Total expenditure on this program up to 1978 was W 92.5 billion at current prices (US$ 191 million). Government support of the electrification program amounts to W 73.8 billion, the balance was provided from KECO's cash generation (W 11.1 billion) and consumer contributions (W 7.6 billion). The rural consumers are meeting the entire cost of wiring their houses and part of the cost of the distribution facilities, by means of loans at 35 years with 5 years grace, at 7.5% interest. Repayments are included in the monthly electricity bills.

Future Development

1.20 The long-term development plan (1978-2000) for the electricity sector, which forms part of the overall energy plan, provides for the substitution of oil (71.9% in 1978 and 12.5% in 2000) by imported coal to fuel the future thermoelectric plants. It also includes the development of an ambitious program for nuclear power plants to meet the basic load, in addition to the development of all economically exploitable hydroelectric resources, and the installation of pumped storage plants to help handle peak loads. The development plan prepared by KDI for KECO provides for an increase in installed capacity from 6,916 MW at the end of 1978 to some 80,000 MW by the year 2000. There is some doubt regarding the feasibility of this program since it includes the construction of about 47 nuclear power plants with a combined capacity of the order of 50,000 MW (equivalent to total US nuclear power installed capacity at the end of 1978), of which only one is in

operation (KORI-1, 579 MW) and four are under construction (3,129 MW). Part of this capacity would be associated with the installation of pumped storage plants (9,000 MW), although in many cases the economic studies that would justify these possible projects have not yet been carried out.

1.21 The expansion program up to 1986 is firmly committed with the exception of a few minor projects that should come on line in 1986. The program comprises a net aggregate capacity of 14,280 MW, including projects under construction (8,032 MW), new projects (6,593 MW) and the withdrawal from service of about 345 MW of old and inefficient thermal facilities. Most of the hydro plants included in the program are part of multipurpose projects, and will make only a small contribution to the electricity system (283 MW), with the exception of the 460 MW Chungju project (para. 1.14). Details of the program are given in paragraph 3.09 and Annexes 4 and 5.

1.22 The long-term expansion program (1978-2000) is tentative beyond 1986. Because the expansion program up to 1986 has more reserve capacity than is required to adequately meet the increased load (para. 3.10 and 3.11), and because the lead time for a nuclear power project is normally 10 years from the date the decision is taken to the date of entry into service, KECO has agreed to submit to the Bank no later than June 30, 1981 a revised power development program for the period to 1991, with proper justification of its components (feasibility studies), for the pumped storage plants, tidal projects, multipurpose hydro projects, etc. taking into account the effects of the energy conservation measures recently adopted by the Government, so that from 1987 the country will have an expansion program based on the least cost solution.

Investments

1.23 Investment in the sector over the period 1979-1986 is estimated at around US$27 billion at current prices (approximately US$19 billion at 1979 prices) of which 38% would be the foreign exchange component. Of this total, KECO's investment would represent approximately 94% (US$25.4 billion). The proposed expenditures in the sector up to 1986 are shown below:

	--------US$ million--------		
	Local	Foreign	Total
Generating facilities	6,557	7,100	13,657
345 KV transmission facilities	814	123	937
154 KV and below and distribution facilities	3,583	205	3,788
Other	435	-	435
Total at 1979 prices	11,389	7,428	18,817
Price escalation	5,287	2,670	7,957
Total at current prices	16,676	10,098	26,774
%	62.3	37.7	100.0

Tariffs

1.24 Electricity rates are approved by Government. Changes in the schedules are first proposed by KECO to MER and after review by the Government Price Stabilization Committee submitted to Cabinet and then issued as Presidential Decrees. In the past changes in the rates have been approved promptly.

1.25 The structure of rates has generally not reflected costs of supply to the respective consumer categories. Government has tended to encourage industrial development through low electricity tariffs and has offered special discounts to certain industries such as aluminum. However, the discounts were removed in November 1976. Similarly, residential consumers have been subsidized by being excluded from general rate increases. Some improvements in the structure have been made since the oil price increases in 1973; declining block tariffs have been replaced by progressive tariffs and peak load pricing has been introduced for large industrial customers. In June 1979, Government modified the rates for residential and commercial consumers, as part of its energy conservation program to provide penalty rates for consumers using in excess of 300 kWh a month. These new rates (para 3.07) are in excess of the long-run marginal costs of supply.

1.26 A marginal cost pricing study is being undertaken for KECO by Electricite de France (EDF) under a technical cooperation agreement with KDI. A report is expected towards the middle of 1980. During negotiations KECO agreed to submit a copy of the study with its recommendations to the Bank by December 31, 1980 for review and comment. KECO has also agreed to consider application of marginal cost based electricity tariffs and the Government has agreed to review and consult with the Bank on this matter and take all necessary action to implement the changes agreed between KECO and the Bank to apply power rates based on marginal costs.

2. THE BORROWER

Organization and Management

2.01 KECO is managed by a board of directors comprising a president, two executive vice-presidents and six vice-presidents. The president of KECO is appointed by the President of the Republic on the recommendation of the Minister of Energy and Resources; the executive vice-presidents are appointed by the Minister and the vice-presidents are elected by the shareholders for three years and approved by the Minister. The members of the board all participate actively in the management of the company.

2.02 KECO's present organization is shown in a simplified form in Chart 20409. There are several anomalies in KECO's organization which must constrain effective planning, management and control, for example: there are three departments concerned with planning under separate vice-presidents: planning and control, engineering, and nuclear power planning. There are also three departments arranging loans: finance, overseas materials, and nuclear power planning. KECO's main function of distributing electricity is coordinated through 21 branches. Each branch has separate sections each independent of the others, responsible for construction, operation and maintenance of transmission and distribution lines. Coordination between all these sections within the branches with KECO's main head office would appear to pose increasing organizational problems as the system is expanded. For example in 1978, KECO's middle-management staff at the section or subsection chief level accounted for 17% of all KECO's personnel. Clearly the continued growth of KECO's organizational structure along historical lines would not be appropriate to the needs of the expected greatly enlarged system in the '80s.

2.03 Early in 1978 KDI completed a report recommending improvement in KECO's organization and management to meet its needs in the eighties. The KDI report recommendations included the following:

(a) KECO be reorganized into three boards; construction, generation and transmission and business, the last mentioned would include distribution;

(b) establishment of a total management information system;

(c) development of a master plan for manpower;

(d) establishment of a policy council to take over the Government's regulatory functions over matters such as operating policies, development plans, electricity rates, organization, staffing and salaries, etc.; and

(e) provision of greater autonomy to KECO's management especially over procurement, staffing and budgetary affairs.

2.04 Little or no progress has been made in implementation of the KDI recommendations. The Government appears to be under no particular pressure to change the status quo. The reason advanced by MER for the Government's inaction was the latter's lack of confidence in KECO's management. There is also (as mentioned in para. 1.12) the question of the interests of the private shareholders whose shares will have been acquired by the end of 1981. In the interim both KECO and the Government have supported the Bank's suggestion of an independent review of KECO's management and organization including the role of Government in the sector especially with respect to planning, procurement, salaries, staffing and organization. KECO has agreed to engage foreign consultants under terms of reference acceptable to the Bank to make recommendations on the best form of management and

organization for KECO. The study will be financed from the proposed Bank loan and KECO has agreed to submit to the Bank a copy of the consultant's recommendations for review and comment by December 31, 1981. The consultant's services have been estimated at US$0.75 milion at 1979 price levels with approximately 72 man-months and a total cost of US$10,400 per man-month.

Manpower and Training

2.05 KECO is the largest Government-owned public corporation in the country. It has over 15,000 full-time employees (excluding construction staff) and expects to have over 20,000 by 1986. The staff establishment, salaries and conditions are approved by the MER. Salaries are low by comparison with the private sector. Average monthly salaries, including overtime allowances, bonus and compensation for annual leave range from about $350 for skilled workers to about $1,350 for managers. Staff turnover is a problem, exceeding 6% in 1977. KECO is having difficulty retaining competent and experienced staff at all levels. Continuation of this trend could severely constrain KECO's ability to construct, operate and maintain the rapidly expanding electricity system. In recognition of the problem it is already paying staff of its nuclear divisions 20-30% above its normal salary levels. The Government, while fully recognizing this problem is anxious to curb inflation and not willing to engage in competition with the private sector to retain its qualified personnel or to create differing salary levels between its own corporations. Nevertheless, the adoption of higher salaries especially for KECO's technical staff should be encouraged on the basis of the highly specialized needs of the power sector. The Government has agreed to take appropriate steps no later than June 30, 1981 to ensure that KECO can recruit and retain qualified staff.

2.06 KECO is giving strong support to manpower development and training. It has developed manpower plans through 1987 and has recently reorganized its technical high school spending 5 billion won (US$10 million equivalent) on new buildings and facilities. Total enrollment will be 1,800 students. It also has its own training center with facilities for 324 persons. The training center runs a wide variety of short courses with emphasis on the technical aspects. During 1979 it expects about 8,000 of its employees to attend these courses. Considerable emphasis is given to language training. In 1981 KECO plans to establish an advanced technical college. Training facilities have also been developed for personnel in the nuclear divisions. Overseas on-the-job training is being carried out for plant operators and overseas procurement staff. KECO's long-term manpower development plans and training programs are considered adequate for its needs.

Accounts and Audit

2.07 KECO prepares an annual budget which is approved by EPB and MER. However, it is not required to submit its long-range financial plans to the Government for approval. Under the Korea Electric Company Act rates may be

set to provide a fair return on investment. However, Government and KECO are not committed to meeting any financial performance targets with respect to rate of return, internal cash generation or the level of debt service coverage.

2.08 KECO's accounting system is based on the uniform system of accounts of the US Federal Power Commission. It is bound by Government regulations and follows the generally accepted accounting principles in Korea which are set out in Presidential Decrees. KECO has little autonomy in financial matters; foreign borrowing and revaluation of assets are regulated by law. It is required to submit its financial statements to MER 20 days prior to the annual general meeting which is held within 2 months of the end of the year.

2.09 The accounts are well prepared and the financial statements are completed promptly at the end of each year. Much of the accounting in the past was until recently dependent on manual labor-intensive methods but most functions are now being transferred to computers. KECO's financial forecasts are prepared using a well-designed financial forecasting model.

2.10 The financial statements are audited by San Kyong and Company which is affiliated with the international firm, Touche Ross and Co. The auditors' reports are prepared promptly and are usually completed within 6 weeks of the end of each fiscal year. They are comprehensive, contain detailed notes to financial statements and a summary statement outlining the scope of the examination. The auditors are elected for two years by the shareholders subject to the approval of MER.

2.11 Each year at least since 1974 the auditors have given a qualified opinion on KECO's accounts because its annual provisions for employees retirements benefits have been inadequate. KECO has been unable to make up the deficits so far because Government has not permitted adequate budget provisions for these commitments. KECO has recently agreed with the Government that provisions will be increased so as to make up the deficits by the end of 1981. KECO has agreed to submit its annual financial statements audited by San Kyong and Co. or other independent auditors satisfactory to the Bank within three months of the end of its fiscal year.

Insurance

2.12 KECO's property department maintains a self-insurance scheme for all risks and automobile accident insurance. In addition to its self-insurance, KECO takes out compulsory fire insurance on all buildings over 1,000 square meters in the largest cities in accordance with compulsory fire insurance law and also pays for nuclear contamination protection. The overseas materials department takes out marine cargo and erection insurance. Given the diversified nature of KECO's assets and their value, the present insurance arrangements are considered appropriate to KECO's needs.

3. THE POWER MARKET

Historic

3.01 KECO supplies the country's entire electricity market. Since practically the whole of Korea is served by the integrated system, with the exception of the islands and a few remote mainland areas, this means that over 98% of the electricity service is provided through the interconnected system.

3.02 Electricity sales totaled 27,326 GWh in 1978, and have grown at an average annual rate of 20.2% since 1961, the year of the company's formation. Over the same 17-year period electricity generation increased from 1,773 GWh in 1961 to 31,510 GWh in 1978. The growth of the electricity market between 1961 and 1978 is detailed in Annex 2 and summarized below:

	1961	1971	1975	1978	(1961-78) Average % annual growth
Energy Sales (GWh)	1,213	8,884	16,630	27,326	20.2
Lighting	228	1,232	2,130	3,959	18.3
Small power	148	646	1,130	5,061	23.0
Large power	816	6,968	13,286	18,116	20.0
Agricultural	21	38	84	190	13.9
T and D losses (%)	28.0	11.4	11.3	8.4	-
Net generation (GWh)	1,684	10,029	18,751	29,909	18.5
Plant use (%)	5.0	4.4	5.5	5.1	-
Gross generation (GWh)	1,773	10,541	19,837	31,510	18.5
Load factor (%)	66.2	67.7	67.6	70.3	-
Peak demand (MW)	306	1,777	3,351	5,118	18.0
Installed capacity (MW)	368	2,628	4,720	6,916	19.0

In this period, the increase in electricity generation averaged 18.5% annually compared with GNP growth of approximately 9.3%. This was due to unusual growth in the demand for electricity arising from spiralling industrial development. (The mining and manufacturing production increased each year at an average of 17.3% and its contribution to GNP rose from 15.2% in 1961 to 28.2% in 1978.)

3.03 The demand for electricity for residential use increased more than 17 times over the period 1961-1978, at an average annual rate of 18.3%. This was due to the rapid rise in per capita income (US$82 in 1961 and US$820 in 1977), from the increased use of household appliances and from the Government's countrywide electrification program, which brought the number of consumers from 770,000 in 1961 up to 4,778,000 in 1978 (an annual increase of 11.3% in the number of residential consumers).

3.04 Losses on the transmission and distribution systems have been substantially reduced (from 28% in 1961 to 8.4% in 1978) due to expansion of the transmission and distribution systems, conversion of the primary networks to higher voltages, introduction (in 1976) of the 345 KV high-voltage network, and installation of generation facilities in the country's different regions, allowing for a better generation/distribution balance. Also the elimination of pilferage has contributed to the reduction of losses.

Load Forecast

3.05 The long-term demand forecast for power and energy has been prepared by KDI and is based on the use of econometric models applied to each end user category. KECO has also made its own forecasts, using simpler econometric equations. Both projections are similar, with a deviation between them of only 4% up to year 2,000. In both cases, the electricity demand forecasts are based on economic parameters fixed by KDI, as shown below:

	1977-1981	1982-1986	1987-1991
GNP	10.20	10.00	10.00
Mining and manufacturing	15.20	12.80	11.40
Elasticity GNP	1.60	1.31	1.17
Elasticity mining and manufacturing	1.07	1.02	1.03

3.06 The expert who took part in the Korean energy study financed by UNDP considers that the procedures used by KDI for estimating the long-term demand for electricity are questionable because of the few observations available (1962-1976), the lack of adequate data for some of these years, and the large number of variables included in the equations used. Also, since the reliability of these forecasts largely depends on the accuracy of the estimates of the independent variables, he recommends that these models be used to supplement rather than replace the time series analysis or other analytical methods, and that KECO be assigned final responsibility for estimating demand. The Bank supports this recommendation.

3.07 In June 1979, the Korean Government adopted a number of energy-conservation measures designed to reduce overall energy consumption by 5%. These measures which are applied nationwide include:

(a) air conditioning equipment not to be used during the summer except between July 10 and August 20. This does not apply to hotels in the international category;

(b) no illuminated signs and no lighting of shop windows;

(c) reduction in the number of lights in the stores (between 25% and 50%) and incandescent bulbs to be replaced by fluorescent tubes;

(d) no illumination of sports grounds;

(e) imposition of a very high surcharge on residential and commercial consumers using over 300 KWh per month from US¢ 20.0 per KWh between 301 and 450 KWh up to a maximum of US¢ 94.0 per KWh over 2,000 KWh per month (average power rates up to 300 KWh are US¢ 12.2 per KWh); and

(f) more efficient use of electricity in industry.

As a result of these measures, KECO estimates that electricity consumption will drop this year by about 1,200 GWh and about 500 MW in relation to the demand forecasts.

3.08 The 1979-1986 demand forecasts refined by the mission show an increase in energy sales from 27,326 GWh in 1978 to 74,844 GWh in 1986; an average annual growth rate of 13.4%. The estimated sales distribution shows that consumption trends in the different user categories will not change much from 1978: large industry will consume 69%, small industry 17%, and the residential and general sector 14%. In accordance with the Government's present program, generation capacity will increase by approximately 14,300 MW, while maximum demand will reach about 14,000 MW by 1986. Details are given in Annex 3 and are summarized below:

	1979	1983	1986
Energy Sales (GWh)	31,424	52,594	74,844
Lighting	4,502	7,470	10,608
Small power	5,775	9,088	12,334
Large power	20,962	35,768	51,544
Agricultural	185	268	358
Gross generation (GWh)	36,306	60,689	86,077
Load factor (%)	70.5	70.8	70.0
Peak demand (MW)	5,879	9,785	14,037
Installed capacity (MW)	8,035	13,443	21,196

The Expansion Program

3.09 The generation expansion program for 1979-1986, provides for the installation of 14 thermal stations totalling 6,553 MW, 5 hydro plants totaling 743 MW, 3 pumped storage stations totalling 1,400 MW, and 7 nuclear power stations with 5,929 MW. The breakdown of the various projects is given in Annex 4.

3.10 As can be seen from the table in paragraph 3.08, the system's reserve seems excessive. KECO is strongly against considering any change or reduction in the present program, since construction of some of the major projects, particularly the nuclear plants, could be delayed, and because the growth in the demand for electricity over the medium term has traditionally been greater than estimated. Certain of the projects under construction have indeed been delayed, and it is also possible that some of the projects still to be started will not be completed on time owing to over-optimistic scheduling. In any case, even if these two conflicting phenomena should occur simultaneously, namely a demand higher than the forecast and a delay in entry into service of certain major projects, KECO should not have any problems in satisfactorily meeting the growing demand for electricity up to 1986, since the level of reserves will still be well over 30% for that year.

3.11 Since a high reserve capacity is a nonproductive investment, some sensitivity analysis should be carried out in the future studies of the expansion program to avoid substantial over-investment in the sector by adopting less pessimistic assumptions for forced outage rates, scheduled maintenance, minimum and maximum permissible reserve margin (%) in critical periods. The current assumed derating for the nuclear power plants (40% during the first year and 20% during the second year of operation) should also be modified. The isolated system should be considered separately from the interconnected system (it was erroneously included in the current studies), and the reliability of the service should be analyzed in terms of a cost-benefit ratio. The implementation of the least cost power system development models (like the WASP model used for the present power expansion development) must be carefully planned and should be carried out by staff with economic as well as technical knowledge of power systems working full

time in this field. In this respect the existing arrangements whereby KDI is responsible for the power system development studies under short-term contracts with KECO does not appear ideal. Steps should be taken immediately to attract the necessary highly qualified personnel within KECO's organization, in order that the main responsibility for the generation planning studies be given to KECO rather than other governmental agencies. The Government of Korea has agreed to allocate to KECO the main responsibility for the preparation of the electric power development program in collaboration, as necessary, with other governmental agencies.

3.12 The WASP Program, does not allow for analysis of the alternatives for electricity transmission. This is not of any great significance for Korea, because:

(a) the number of sites suitable for the construction of large conventional or nuclear power plants is limited by reason of national security and because many of these areas are heavily populated;

(b) the hydro and pumped storage plants under construction or at the design stage are relatively close to the load centers; and

(c) the 345 KV and 154 KV transmission lines are relatively short.

Thus the change in the discounted costs of the different transmission alternatives will be practically insignificant.

3.13 The transmission and distribution expansion program (details in Annex 5) includes expansion of the 345 KV system with a view to interconnecting the different regions of the country and connecting the largest plants to this voltage, to ensure greater stability in operation of the system in both steady and transient conditions. The basic aim of expansion of the 154 KV system is to supply the energy required in each region and to establish ring main systems around the largest cities. KECO anticipates restricting future extensions of the 66 KV lines and completing the increase in the voltage of the primary distribution networks from 3.3 KV and 6.6 KV to 22.9 KV, and that of the secondary distribution networks from 100/200 V to 230/380 V. A summary of the proposed projects up to 1986 is given below:

	Existing	Extensions	1986
Transmission Lines (km)			
345 KV	1,143	3,584	4,727
154 KV	5,124	6,014	11,138
66 KVs below	4,519	155	4,674
Distribution Network			
Lines (km)	108,074	34,830	142,904
Pole transformers (MVA)	4,702	7,360	12,062

4. THE PROJECT

4.01 The Gojeong thermal power project constitutes the logical next step in the program to meet the load growth up to 1986, which over the last 17 years has increased at an average of 18.5% a year.

Location

4.02 The project site is located on a hilly peninsula on the west coast of the country in a virtually unpopulated area, approximately 14 km by road from Daecheon city (population 45,000), the area's commercial center and approximately 40 km north of the port of Kunsan. The site is adequate for the ultimate installation of six units similar to the first two 500 MW units planned for the project (see Chart 20408).

Project Description

4.03 The Gojeong project comprises:

(a) a thermal power station with two 500 MW coal/oil fired units, and associated auxiliary equipment;

(b) coal handling and storage facilities, fuel oil tanks, ash system and storage area;

(c) a fuel unloading dock for ships of up to 100,000 DWT displacement;

(d) a pumping station and a 17 km steel pipe to transport fresh water to the station, with a 5.3 cu m/min capacity sufficient for the first four 500 MW units; and

(e) a 160 km of double circuit, 345 kV transmission line between the Gojeong power project and Seoul, and related terminal substations.

4.04 The two units will be constructed as a complete station, using certain common facilities but without provision for expansion of the main buildings to accommodate additional units. The turbines will be a 3,600 rpm tandem compound, four-flow, single reheat type. The generators will be 577,000 kVA, 2-pole, 60 cycles, rated at 0.9 power factor with the rotor cooled by hydrogen at a maximum pressure of 4.1 kg/ sq cm, together with a water-cooled stator. The excitation system will be a solid state type. The steam generators will be a drum type, balance draft units, rated at boiler outlet conditions of 170 atm and 540°C with a production of 1,679 tons/hr of steam.

4.05 The transmission line will cross firm but flat terrain, with the exception of about 48 km (30%) of hilly areas with elevations of up to 600 m. Lattice steel towers for double circuit will be used carrying four bundle conductors per phase of 954 MCM, ACSR, shielded by two 75 sq mm steel wires. The diameter of the conductors and the arrangement of quad bundles was adopted

in order to increase the surge impedance level (SIL) and obtain low power losses. Double insulator strings consisting of 18-20 units per string will be used for suspension towers and triple insulator strings for retention towers.

Fuel Supply

4.06 Annual consumption of imported bituminous coal for the station's ultimate capacity (3,000 MW) is estimated at approximately 6.6 million tons. This would require, according to the consultants, about 85 ships to be unloaded at Gojeong each year. In view of the need for continuous operation, the dock and coal unloading facilities will be built to the final capacity to avoid serious interference that would be caused by subsequent expansion in the same work area. Coal requirements for the project are estimated at 2.2 million tons a year and would be probably imported from Australia, Canada, South Africa and USA. KECO received bids in March for long-term supply contracts and is evaluating the proposals. On average, each coal producer would supply about 500,000 tons a year for a 4-year period. The Gojeong power station will use Bunker C as an alternative fuel. The project includes the installation of four storage tanks with a unit capacity of 500,000 barrels sufficient for four 500 MW units for 30 days' operation at full load. The fuel would be acquired from the local refineries.

Estimated Cost

4.07 The project is estimated to cost US$657 million excluding custom duties and financial charges. The foreign currency component is estimated to be approximately US$192 million. The costs, which are detailed in Annex 6 are summarized as follows:

PROJECT COST

	W million			US$ thousand		
	Local	Foreign	Total	Local	Foreign	Total
Generating facilities	145,666	70,801	216,467	300,345	145,981	446,326
Transmission facilities	21,594	3,056	24,650	44,527	6,300	50,827
Consultants	73	291	364	150	600	750
Base Cost	167,333	74,148	241,481	345,022	152,881	497,903
Contingency - Physical	13,704	4,310	18,014	28,251	8,887	37,138
- Price	44,413	14,899	59,312	91,574	30,716	122,290
Total Project Cost	225,450	93,357	318,807	464,847	192,484	657,331

4.08 The base estimates for the thermal power station were prepared by the consultants Bechtel International Inc. and Associates, who conducted the Gojeong feasibility study. The estimated quantities, equipment sizes,

ratings, etc. were developed by the consultants on the basis of data available on other similar projects and adjusted to the requirements of the Gojeong site. The estimated costs are based on price levels at the beginning of 1979 with the exception of the main equipment (turbine generators and boilers) preliminary civil works and consultants services for the engineering of the project, for which contracts were made in September 1979 on the basis of fixed prices. Transmission estimates are based on the costs of 345 kV systems under construction at various locations in Korea. A physical contingency of 10% on the overall cost has been allowed to cover variations in labor productivity, unit costs, quantities, etc. The price contingencies for foreign costs were calculated on the basis of assumed annual rates of escalation of 10% for 1979; 9% for 1980; 8% for 1981 and 7% for 1982-84. For local costs the price contingencies adopted in the cost estimates are: 14% for the first semester and 10% for the second semester of 1979; 9% for 1980 and 8% for 1981-1984. These are in line with expected price increases in Korea.

Project Financing

4.09 A Bank loan of US$115.0 million equivalent is proposed representing 60% of the foreign exchange cost of the project. It has been assumed that the proposed Bank loan would be for 17 years including a 4-year period of grace. The loan would finance part of the foreign exchange cost of pumps, heaters, coal and ash handling equipment, auxiliary mechanical and electrical equipment, communication system, materials and equipment for the transmission system and management consulting services. No retroactive financing is proposed. KECO would bear the foreign exchange risks on the proposed Bank loan and would finance the interest during construction from its own sources of funds.

4.10 The remaining foreign costs which would be for the main equipment items i.e., the turbine generators and boilers, would be financed by export credits and a syndicated loan. Toshiba (Japan) would finance 85% of its share of the cost of the turbine generators at an interst rate of 7.5% per annum repayable over 12 years and the Export-Import Bank of the United States (EXIM) would finance a similar percentage of the cost of the boilers at 8% interest repayable over 12 years. The syndicated loan is being arranged through Samuel Montagu & Co. Ltd. (UK) and is expected to be offered at 1/16 of 1% above the London interbank rate (LIBOR). The local costs of the proposed project would be met by KECO from its own internal sources and those acquired as part of its annual borrowings for financing its development program. Although KECO is expected to be able to obtain without difficulty all the funds it will require for construction of the project on reasonable terms, the Government has agreed to meet any shortfall in funds required for completion of the project.

Engineering and Construction

4.11 KECO is financing with its own funds the cost of engineering services for detailed design and technical advice during construction of Gojeong. The consultant (AMTAI) would also develop a training program to

familiarize KECO personnel with the techniques of design of various power plant systems. The consulting firm is considered suitable by the Bank. AMTAI was registered as a joint venture between American Bechtel Inc. (USA) and Taihan Engineering Company Ltd (Korea) in November 1978 under Korea's Foreign Capital Inducement Act. Engagement of consultants for the transmission component would not be necessary because KECO has good experience in the design and supervision of projects at 345 kV.

4.12 The consultant estimates that the Gojeong construction will take about 4-1/2 years. As the preliminary civil works (excavations and grading of site) have started and the main equipment has been ordered, it is expected that the first structural concrete would be poured by March 1981. This activity determines the critical path for project completion presently scheduled for October 1983 for the first unit and April 1984 for the second unit (mission estimates). The Gojeong power plant construction schedule is reasonable. There is a probability of 90% that the project will be completed in the period roughly between 51 and 57 months from the starting date. The simplified implementation bar schedule shown in Chart 20410, would be used to monitor progress during the construction period.

4.13 A total of four local manufacturers of boilers and turbine-generators equipment were invited to submit tenders at the end of December 1978. The invitations were issued to local manufacturers in line with the Government policy of fostering the local industry, together with the names of foreign manufacturers (13 for turbines and 11 for boilers) recommended by KECO to be associated with local firms to guarantee the performance of the equipment. The contract for the turbine generators was made on September 10, 1979 to the lowest evaluated bidder, a joint venture between Daewoo (Korea) and Toshiba (Japan). The contract is based on a fixed price and amounts to US$39 million including spare parts and supervision during erection. The foreign exchange component represents 82% of the total contract price. The contract for the boilers was made on September 24, 1979 to Hyundai Heavy Industries Co., Ltd. (Korea) with associated supervisory services from Babcock & Wilcox Co. (USA). The contract is also based on a fixed price and amounts to US$87.2 million including spare parts and supervision during erection. The foreign exchange component is 36.4% of the contract price and comprises the supply of drums, atemperators, fuel burning supply, control system with instrumentation, training and supervision fees, spare parts and contingencies. The costs of these equipments are attractive.

Procurement

4.14 Procurement of all equipment and materials to be financed by the proposed loan would be on the basis of international competitive bidding in accordance with the Bank's procurement guidelines. Bidding documents, including recommendations for award of contracts, would be prepared by KECO with the assistance of AMTAI and approved by the Bank. Korean manufacturers would receive a preference of 15% or applicable duties, whichever is the lesser, for purposes of bid evaluation. Local manufacturers would be

expected to bid for certain items of electro-mechanical equipment for both generating and transmission facilities. Contracts for equipment of less than US$500,000 would be tendered without prior approval from the Bank.

4.15 The Office of Supply of the Republic of Korea (OSROK) is charged with the specific responsibility to act as procurement agent for international lending institutions for all publicly-owned bodies. The Bank discussed with the Government the desirability of making KECO responsible for procurement under the proposed project in view of the long-term goal of affording KECO with the maximum amount of autonomy, and also because KECO already has the responsibility for its procurement, both local and foreign. During negotiations, the Government has given informal assurances that KECO will be given full responsibility for procurement of the goods to be financed from the proposed Bank loan.

Disbursements

4.16 Funds from the proposed loan would finance:

(a) 100% of the foreign expenditures for the imported materials and equipment ;

(b) 100% of ex-factory cost of equipment and materials manufactured locally; and

(c) 100% of the total cost for consultant's services.

Annex 8 shows estimated loan disbursements, assuming loan effectiveness in March 1980. The closing date would be December 31, 1984 to allow for the payment of retention moneys.

Environmental Aspects

4.17 The area surrounding the project site is characterized by mountainous topography, with the exception of several small valleys which have been reclaimed by drainage. A small village of 21 houses has been removed from the work site. The compensation payments were some US$3.1 million equivalent. The dominating wind directions are from WNW, 14.1% and ENE, 13.2% of the time which are favorable.

4.18 The design grade coal anticipated for use at the Gojeong station has a maximum sulphur content of 1% on an air dry basis and the oil to be used as an alternative fuel would be limited to a maximum sulphur content of 3% to meet the permitted emission levels imposed by the Government regulations (Decree No. 9066 of July 1978). Therefore, no flue gas desulfurization system would be necessary. A precipitator with a 99.5% efficiency level would be installed at the station between the economizer and the boiler air preheater (hot precipitator). To allow for the possible use of other fuels with different characteristics in the future, space has been anticipated for the installation of SO_2 scrubbers for each unit (see Chart 20408).

4.19 A stack height of 150 m from the ground has been proposed. However, final selection of the stack height will be determined during the plant design stage after completion of studies of the meteorological data of the site and of the characteristics of pollutant dispersion of the area. KECO has agreed to submit to the Bank by December 1980 an air quality study and to make its best efforts to assure that the maximum predicted ground level concentration of SO_2 will be below the Bank's recommendations of 100 ug/cu m (annual arith. mean) and 1,000 ug/cu m (max. 24 hrs).

4.20 Each unit would have a circulating water flow rate of about 20 cu m/s and a condenser temperature rise of 7.3° C. A preliminary study has been made by the Korean Institute of Science and Technology (KIST) to collect data relating to the marine organisms and ecosystems in the ocean, adjacent to the Gojeong site. Although no significant impact on the marine environment is expected from the discharge of hot water, the study is continuing at different periods of the year to determine the full impact of the power plant on the marine environment and to provide the basis for the final design of the circulating water system.

4.21 The amount of ash production for the first two 500 MW units will be approximately 450,000 tons per year for the grade of coal adopted. The initial area selected for ash deposit would be of 24.6 ha sufficient for 10 years. A remaining 64 ha in the same area would serve four 500 MW units for 14 years and a 95 ha area, which would be developed later, would serve to meet the needs of six 500 MW units for a further 14 years. The consultants have recommended measures to control seepage and storm runoff.

4.22 The Gojeong station will be designed to ensure that the noise level is kept as far as possible at no more than 55 decibels in compliance with government regulations. In view of the low noise level required, it is highly likely that sound enclosures will have to be installed on the boiler forced draft fans and also sound panels for some miscellaneous yard equipment.

4.23 No environmental problems with the transmission line are anticipated. The transmission line will cross rural areas that are sparsely populated, with little farming activities and sparse woodlands. Compensation would be paid for any losses sustained by the owners of cultivated areas and for the use of rights-of-way. Radio and television interference levels would be minimal because of the adoption of four bundle conductors per phase.

Geology and Seismicity

4.24 Geological and foundation conditions of the Gojeong site and surrounding area have been studied by a local consultant (Sambo Geologic Company, Ltd.). The rock at the site is considered good enough to provide a very acceptable foundation for all of the plant block structures. Additional soil and foundation investigations will be done in the vicinity of the docks. A seismic refraction survey has indicated that about two thirds of the excavation will require blasting.

4.25 Several small tremors have occurred in the vicinity of the site proposed for the project. The consultant considers, on the basis of the seismic history of the region, (corresponding to intensity levels of less than or equal to IV on the modified Mercalli scale) that the site is appropriate for the erection of the station.

Risks

4.26 KECO is experienced in the construction of power-plants; Bechtel is well known internationally and has good experience in Korea (Bechtel is also the consultant for design and engineering for nuclear power units 5 and 6). No difficulties are expected in fuel supply or other operational aspects. The project risks are no greater than would normally be expected with other developments of this nature.

Completion Report

4.27 In order to inform the Bank about the results of the project, and the lessons learned during its execution, a completion report will be prepared following the closing date of the loan. KECO has agreed to prepare a report on the execution and initial operation of the project, its cost and the benefits derived and to be derived from it and of its performance of the obligations under the Loan Agreement.

5. FINANCE

Past Performance and Present Position

5.01 Following the oil crisis in 1973, KECO made some structural revisions to its electricity rates which increased revenue by about 6%. However, it did not increase rates significantly until February 1, 1974 when a 30% increase was introduced. In fact, it was not until December 1974 that action was taken to try to recover the increased costs of fuel, which in the case of fuel oil had tripled in cost since October 1973. As a result rates were raised in December 1974 a further 42% except for domestic consumers whose share of the market was only about 12%. Unfortunately the December 1974 increase was made too late in the year to make up for the loss in revenue from the higher fuel costs and KECO's revenues barely covered its operating costs. The rate of return on average net fixed assets and working capital in 1974 was only 1%. At this rate of return, KECO's net income was not sufficient to meet its debt service commitments.

5.02 Since the end of 1974 rate increases have been greater than the increases in costs and as a result KECO's financial performance has improved significantly. In 1977, its rate of return/1 reached 12.1% and in 1978 it was 11.3%, quite good returns. With these rates of return, KECO has been able to meet its debt service commitments adequately (1 1/2 times coverage) and finance on average, in the last two years, about 14% of its capital expansion. KECO's financial statements are shown in Annexes 9, 10 and 11.

5.03 While KECO's financial performance has improved considerably since 1974, the results obtained need to be analyzed further to determine what its performance would have been if its accounting had been done on a consistent basis with that used in 1974. Firstly, effective January 1977, KECO suspended the annual revaluation of its assets following the Government 's decision to buy out the interests of KECO's private shareholders. This was done to prevent further distribution of revaluation surpluses to the private shareholders which were needed for financing KECO's expansion. If KECO had continued to revalue its assets in 1977 and 1978, the rate of return in these years would have been lower than shown in Annex 9 by 0.6% in 1977 and 1.1% in 1978.

5.04 Secondly, KECO revised its depreciation policy in 1976 to reduce the average life of its plant in service from about 30 years to about 18 years because the rates in use up to 1976 were not considered to reflect realistically the useful life of the plant in view of the rapid technical changes in the industry. This change in depreciation policy reduced KECO's operating income and rate of return in 1977 and 1978. If the depreciation rates had not been changed in 1976, the rates of return would have been about 2.5% higher than previously mentioned in the following two years.

/1 On average net fixed assets and working capital.

5.05 Thirdly, the audit reports for each year reviewed (1974 through 1978) contain a qualification which indicates net income has been overstated because of inadequate provisions for employees retirement benefits. In 1977 and 1978 this has resulted in overstatement of the rates of return by about 1% each year. The problem lies with Government which until recently, has not permitted KECO to make adequate budget provision for these commitments. The Government has now arranged with KECO that the provisions will be adjusted to eliminate the deficits by the end of 1981.

5.06 From the above analysis, it can be concluded that if KECO had continued to revalue its assets after 1976, made adequate provision for employees retirement benefits and maintained the pre-1976 depreciation rates it would have achieved rates of return in 1977 and 1978 about the same as mentioned in para. 5.02. However, since these changes do not alter the volume of internal sources of funds, the level of self-financing is not affected.

5.07 Over the past five years, KECO's debt/equity ratio has improved from 70/30 at the end of 1974 to 60/40 at the end of 1978. This improvement in its financial structure would have been greater if it had continued to revalue its assets after 1976. The debt/equity ratio would have been about 54/46 in 1978. KECO has made new issues of shares annually to its shareholders and now has issued 429 million shares of its authorized share capital of 600 million shares. Up to the end of 1976 KECO had made bonus issues of stock to its existing shareholders from the surplus arising from revaluation of assets. The Government share of the revaluation surplus and dividends due on its shares have been retained and reinvested in KECO thus helping to strengthen its financial structure. KECO's existing level of debt to equity will support its plan to borrow a substantial part of its investment requirements in the next few years provided it can maintain an adequate level of earnings and debt service coverage.

5.08 The source of KECO's borrowings has changed slightly since 1974. About 60% of its long-term debt is now from foreign sources compared with about 50% in 1974. About 7% of its long-term debt is being provided in foreign currency by local banks; principally the Korean Foreign Exchange Bank, 38% by foreign commercial loans and 15% from Government guaranteed loans principally from USA, Canada and the United Kingdom. Whereas some years ago much of KECO's borrowing was on concessional terms, it is now having to pay the U.S. prime or the London interbank rate (LIBOR) plus a margin of from 1.75% to 2.25%. The average interest rate on all borrowings in 1978 was almost 9%. Although the LIBOR and prime rates are much higher (being in the 15-16% range), KECO is now obtaining commercial bank loans with margins below 1%; indicative of the high regard which the banks have for KECO's financial position and prospects. With commercial bank rates now so high, export credits and multilateral sources like the Bank and ADB represent very

attractive sources of finance for KECO at the present time. This is especially so given the high cost of local currency loans in Korea. Loans from the Korean Development Bank, KECO's main source of local currency loans, are expensive with interest rates around 15% last June, 1979. Because of the high interest rates on local borrowing, KECO has stopped issuing local bonds and plans to repay in 1979 all bonds outstanding at the end of 1978.

Financing Plan

5.09 KECO's forecast of sources and applications of funds for the construction of the Gojeong Project (1979-84) is given in Annex 11. A condensed version for the same period is given below:

	1979-84		
	Billions of Won	US$ million equivalent	% of capital expenditures
Capital Expenditure Requirements (including interest charged to construction)			
Total investment and working capital requirements	9,011	18,579	100
Source of Funds			
Internal cash generation	4,753	9,800	
Less: Debt Service	(3,581)	(7,384)	
Net internal cash generation	1,172	2,416	13
New Equity	279	575	3
Borrowings			
Foreign - Proposed IBRD loan	56	115	1
Foreign bonds	146	305	1
Other foreign loans	3,956	8,159	44
Local - Public loans	260	536	3
National investment fund	600	1,237	7
Other local loans	2,542	5,241	28
Total Borrowing	7,560	15,588	84
Total sources of funds	9,011	18,579	100

5.10 It will be seen from the above plan that KECO will require about 9,011 billion won (US$18.6 billion) to finance the cost of construction (including interest charged to construction) and increased working capital through 1984. About 84% of this amount will be borrowed, 3% is expected to be obtained from increases in capital and about 13% from internal sources after meeting debt service obligations of 3,581 billion won (US$7.4 billion). Considering the size of the proposed construction program which will increase the value of KECO's gross plant in service by 1984 more than 4 times at current prices and the higher costs of borrowing, the plan is a reasonable one. Critical to achievement of this plan will be the Government's willingness to approve tariff increases sufficient to maintain KECO's creditworthiness and to meet increased costs especially for fuel and debt service.

5.11 Athough KECO's borrowing is large, it does not expect to have difficulty obtaining the funds it needs for financing the program. The foreign costs of many of the larger projects e.g. Kori 2 and Wolseong nuclear plants and Asan and Samcheonpo thermal units have already been provided through suppliers' export credits arrangements. KECO's first foreign Eurobond issue is planned to be offered in the latter part of 1979. If it is successful, it is likely to be followed by others for larger amounts than the US$50 million each year provided in the plan. Other foreign borrowings will be obtained from the Korean Foreign Exchange Bank and foreign commercial banks. Local borrowings may continue to be more difficult and more expensive to obtain than foreign loans because of the limited volume of local funds available. However, KECO is expected to seek public loans through the Korean Development Bank and also its National Investment Fund. KECO has agreed to submit its annual budget and borrowing plans to the Bank for review and comment within two months of the commencement of each fiscal year. The purpose of this review would be to encourage KECO not to incur excessive short-term debt and to minimize its borrowing from commercial and other sources at high market rates. Government has agree to continue to reinvest any dividends on its shares in KECO.

Future Financial Position and Covenants

5.12 KECO's financial plan prepared in March 1979 has been reviewed by the Bank and revised to take account of recently introduced conservation measures and the impact of inflation especially on operating costs, debt service and construction expenditures. The financial forecasts and the assumptions used are shown in Annexes 9, 10 and 11.

5.13 The forecasts show that KECO could achieve rates of return on its average net fixed assets revalued annually and working capital of 14.4% in 1980 rising to 15.8% in 1983 before beginning a gradual decline to 11.2% in 1986 when the Gojeong project and the other major plant in the program will have been commissioned. This level of performance is equivalent to a 9%

rate of return on KECO's rate base (KECO's rate includes 100% of average work in progress). It will enable KECO to maintain debt service coverage of at least 1.2 times; a reasonable level considering the expected high costs of borrowing. The debt/equity ratio should continue to be adequate and will enable KECO to attract further large-scale borrowings at close to market rates. At the same time it would contribute a reasonable portion, about 15% of its own funds towards investment needs. KECO is expected to maintain its very tight control over the level of working capital and especially its good record with respect to collection of electricity accounts which has in the past been equivalent to about one month sales. In fact, during three of the last five years, it has operated with a current ratio of less than one and the forecasts show that this situation will continue.

5.14 In para. 5.04 mention was made of the change in KECO's depreciation policy in 1976 and the fact that the shorter plant lives adopted had reduced KECO's rate of return performance in 1977 and 1978 by about 2.5% in each of those years. By using the depreciation rates based on an average plant life of 18 years, the rate of return shown in the financial forecasts are similarly lower than they would have been if KECO had maintained the previous plant lives averaging 30 years. KECO's pre-1976 depreciation rates were based on the estimated useful life of the plant and the new rates were adopted ostensibly to take account of expected shorter plant lives because of technical changes but actually to increase cash availability. Taiwan Power Company which has a similar power system to Korea's, depreciates its plant at rates which average 30 years. Although KECO's current policy results in accelerated depreciation of its plant, it appears to be an appropriate strategy for KECO to adopt, considering its large requirements of capital, the inflationary environment in which it is functioning and the fact that its expansion program would tend to increase its asset base despite the accelerated depreciation rate. Since we expect it will serve to increase cash availability, the Bank should not object to it provided the financial effects are disclosed in the notes which form part of the companies audited financial statements.

5.15 Since KECO and Government have never established financial performance targets to assist the formulation of its annual and long-term plans, KECO's financial performance has fluctuated according to Government's willingness to approve rate increases. Although KECO is not expecting to have difficulty obtaining funds for its program (para. 5.11), this situation does not assure the Bank and other lenders that KECO's future financial performance will be adequate to maintain a strong financial position. At negotiations, KECO and Government agreed to take all necessary steps to provide revenue to produce an annual rate of return on KECO's rate base after annual revaluation of gross fixed assets and accumulated depreciation sufficient to cover operating expenses including taxes, to provide adequate maintenance and depreciation to meet debt service payments and finance a reasonable proportion of investment requirements. KECO's rate base would be used for this calculation since it is well defined and simpler for KECO to use.

KECO has also agreed to maintain rates for depreciation of its fixed assets in accordance with accounting practices acceptable to the Bank.

5.16 For the purposes of the rate of return agreement, KECO and Government gave assurances in a supplemental letter that tariffs would be maintained sufficient to provide a return of at least 9%.

5.17 In order for KECO to meet the 9% rate of return objective, it would need to increase its tariff about 21% in 1980, 12% in 1981 and 6-7% thereafter through 1986 based on the assumptions contained in the Bank's forecasts. Accordingly, if local inflation is higher than 9% in 1980 and 8% between 1981-86 or oil prices increase more than 6% annually, higher tariff rates would be necessary. KECO and Government gave additional assurances in its supplemental letter on the rate of return to the effect that they would:

(a) pursue their policy of passing on increases in fuel cost to consumers;

(b) modify KECO's investment program to correspond to changes in power demand;

(c) minimize operating costs;

(d) minimize short-term borrowings which involve high interest rates, and;

(e) seek additional equity contributions from Government to meet the rate of return in 1980 and future years.

5.18 In 1979, KECO's rates were increased about 22% and as a result is expected to earn a rate of return on its rate base of about 6.8%. Although KECO is expected to be able to maintain an adequate level of debt service coverage if its achieves a 9% rate of return, KECO and Government have agreed to review the agreed rate of return target whenever KECO's debt service coverage falls below 1.20.

6. ECONOMIC ANALYSIS

Justification

6.01 The Gojeong project, which is part of the national expansion program analyzed in paragraph 3.09, is the least cost alternative for meeting part of the increased demand of the interconnected system from 1984. Gojeong will be the third thermoelectric plant included in the expansion program that will consume imported bituminous coal. The cost of the fuel per KWh would be US¢ 1.4 for coal, and US¢ 2.4 for Bunker C, at the prices in effect on January 1, 1979.

6.02 The project would contribute 8.2% of the system's overall net generation requirements (64,643 GWh) in 1984 and its output would vary between a maximum of 6,174 GWh in 1985, with a plant capacity factor of 73.8%, and minimum of 4,100 GWh in the year 2008. The average plant capacity factor for the useful life of the plant (25 years) would be 56.3%, according to the consultants' study. Although the investment cost in Gojeong would be approximately 30% higher than that of a similar plant designed exclusively to burn fuel oil, the unit generation cost of the latter would be 23% higher in present value; at a discount rate equivalent to the opportunity cost of capital in Korea, which is assumed to be around 14%.

6.03 A very important benefit resulting from the project is the incorporation into Korea of advanced technology in the construction of heavy electro-mechanical equipment, since part of this equipment is to be manufacured locally in association with foreign manufacturers. Another benefit is that Korean industry will be rendered capable, in a very short time, of handling a substantial part of the sector's domestic requirements, and possibly later to participate in the international market on competitive terms.

Return on Investment

6.04 The internal rate of return on the Gojeong project has been calculated as the discount rate at which the present value of estimated costs and benefits (at constant prices) attributable to the project during its useful life are equal. The chain of costs comprises capital expenditures, including a portion of the investment in expansion of the distribution network, and the fixed and variable operating costs. The benefits include only the revenues from the sale of the incremental energy produced by the project at final consumer level. The average selling price of energy is that in effect on January 1, 1979: W 27.7 per KWh, plus 10% value-added tax, reduced by the standard conversion factor for electricity of 0.89. Under these conditions (Annex 13, 14 and 15) the rate of return on the project is 20.1%. A sensitivity analysis shows that if the capital cost and operating costs were

10% higher and the income from sales were reduced by a similar percentage, the project rate of return would be 14.8%, which is practically the same as the opportunity cost of capital in Korea.

6.05 Although the rates structure and current price levels for the different consumer categories do not satisfactorily represent the economic cost of the electricity service at the different voltages, the present average price of the service roughly reflects the marginal cost per KWh over the long term. The rates study currently being carried out by KDI (para. 1.26) is designed to evaluate the marginal cost of electricity in the long term, so that the charge to the consumer will eventually reflect the real cost of the service with a view to obtaining an optimal rate of development in the sector.

7. AGREEMENTS REACHED AND RECOMMENDATIONS

7.01 During negotiations KECO has agreed to:

(a) submit to the Bank no later than June 30, 1981 a revised power development program for the period to 1991 (para. 1.22);

(b) submit a copy of the EDF/KDI marginal cost pricing study to the Bank by December 31, 1980 for review and comment and consider application of marginal cost based electricity tariffs (para 1-26);

(c) engage consultants under terms of reference acceptable to the Bank to make recommendations on the best form of management and organization for KECO by December 31, 1981 (para. 2.04);

(d) submit its annual financial statements audited by San Kyong and Co or other independent auditors satisfactory to the Bank within 3 months of the end of its fiscal year (para. 2.11);

(e) submit to the Bank an air quality study, by December 1980, and to make its best efforts to assure that the maximum predicted ground-level concentration of SO_2 will be below the Bank's recommendations (para. 4.19);

(f) prepare and furnish to the Bank a completion report no later than 6 months after the closing date of the loan (para. 4.27);

(g) submit within two months of the beginning of each fiscal year its annual budget and borrowing plans to the Bank for review and comment (para. 5.11);

(h) maintain rates for depreciation of its fixed assets in accordance with accounting practices acceptable to the Bank (para. 5.15).

7.02 During negotiations, Government has agreed to:

(a) review and consult with the Bank on marginal cost based tariffs and implement changes agreed between KECO and the Bank (para. 1.26);

(b) take appropriate steps by June 30, 1981 to ensure KECO's ability to recruit and retain qualified staff (para. 2.05);

(c) allocate the main responsibility for the preparation of the electric power development program to KECO (para. 3.11);

(d) meet any shortfall in funds required for completion of the project (para. 4.10); and

(e) continue to reinvest any dividends on its shares in KECO (para. 5.11).

7.03 During negotiations KECO and Government agreed that:

(a) tariffs would be maintained sufficient to provide a rate of return of at least 9% (para. 5.16); and

(b) they would review the rate or return target whenever debt service coverage falls below 1.20 (para. 5.18).

7.04 With the above agreements, the project is suitable for a Bank loan of US$115 million to KECO with the guarantee of the Government of Korea. Since the project is expected to be commissioned by 1984, the standard terms for a Bank loan to Korea of 17 years including a 4-year grace period, would be appropriate.

KOREA

GOJEONG POWER PROJECT

Summary of Integrated Energy Policy Objectives and Options
UNDP/IBRD Korea Energy Policy Study

A. Integrated Energy Policy Objectives and Options

1. Energy Demand Policies: Conservation -- The Efficient Use of Energy

(a) General: Korea will wish to restrict energy demand to a reasonable minimum that reflects efficient use of energy in government and productive sectors, and degrees of austerity and efficiency in consuming sectors appropriate to Korea's defense and economic situation.

(b) Productive Sectors: Industry, agriculture, transportation, commerce and other services including government.

The leading consideration in productive sectors must be efficiency if Korea is to compete in foreign markets and to raise production and income levels. Efficiency in energy use will mean more to Korea as the real cost of energy rises in the years ahead. Korea will wish to maximize energy efficiency through use of energy-saving technology, equipment, products, processes and economic structure.

(c) Consuming Sectors: Housing, clothing, personal transportation, restaurants, entertainment, etc.

The consuming sectors face sharply the dilemma of energy policy seeking rapid increases in personal incomes. The ultimate purpose of development and rising incomes is to improve the well-being of the Korean people. But austerity is an essential and important means to economic growth. Thus it is a matter of judgment how far austerity must go at any particular time. At present the rapid growth of recent years is producing a boom in domestic consumer demand. Government must deal with the central dilemma involved, especially with respect to restricting the spread of private automobiles.

2. Energy Supply Policies

(a) General: Korean energy supply policy will inevitably be to meet the nation's needs as defined by demand policy. Supply policy will seek to meet needs continuously, securely and at least cost. Policy will relate to the degree of emphasis on one or another of these three objectives. If security and continuity of supply seem most urgent, then Korea will have to meet whatever costs are implied by these choices. If minimum short-run or long-run cost is deemed crucial, then some supply security may have to be sacrificed.

(b) Optimum mix of fuels. We can accept the fact that the proportion of oil among the fuels consumed in Korea is too high and rising. Because oil may at any moment be unavailable from one or more sources, Korea has already adopted policies to slow down and, in time, to reverse this rising trend.

The prospective increases in oil prices constitute an additional factor in favor of a reduced share of oil. Still, the prices of other fuels are also likely to rise. Coal, both domestic and imported, is cheap enough to be very desirable as a partial substitute for oil now and to a substantial extent on a continuing basis, even after it ultimately reaches 75% of the price of oil.

Korea is also moving rapidly into nuclear energy, partly for the purpose of reducing dependence upon oil. And Korea is already taking early steps to make use of tidal and solar power and other new sources of energy.

The optimum mix of these different fuels will depend partly on estimates of the prospective cost, availability and desirability of each fuel and partly on the relative importance given to price, security, environmental problems and other policy objectives. Judgment of market trends for the longer run will be a vital part of the choosing of the most advantageous mix.

(c) Optimum mix of sources and channels for obtaining fuels. Until the time in the 21st century when solar energy and other new sources reverse the trend, Korea must rely increasingly on imported fuels. Whatever the fuel mix, Korea can improve its situation also by diversifying sources from which imports come, and the channels that bring them to Korea.

Geographical diversification of sources is possible to a limited extent. There is also some room for choice about private firms or government channels for buying oil and coal. Korea would not want to cut itself off from the supply networks of the international oil companies, but could increase its security of supply by dealing with several companies and possibly also through the

activities of the planned Korea Petroleum Development Corporation on government-to-government deals. Although this last approach has yet to prove itself in terms of obtaining more assured supply (and at lower cost).

Likewise, different coal producers are available to sell to Korea, and Korea may well carry its coal purchases in Korean ships.

3. Energy Management Policies.

(a) General. It must be the main purpose of policy concerning energy management to assure that Korea meets its energy needs and objectives as effectively as care, forethought and human effort can make possible, in the light of circumstances, some of which are domestic but many of which are international in origin. Where not all objectives can be satisfactorily met, management policies must see to it that sacrifices are made in matters of lower priority, and that the total sacrifice is as small and equitable as possible, under the circumstances.

(b) Supply: Contingency planning and preparation:

(i) Emergency Planning: Korea is far too dependent on energy imports, and these imports, particularly of oil, are far too susceptible to decisions of producers. Prudence requires that Korea have plans for emergencies resulting from interruptions to the flow of oil imports. Since there is no possibility that in a major interruption of oil supply Korea could procure and use substitute fuels to any significant extent, the two requirements are an emergency stockpile and a plan to limit consumption during the emergency.

An oil stockpile equal to 90 days current demand should be created by the end of 1980.

(ii) Plans for dealing with longer-lasting shortages. If an energy crunch arrives in the late 1980's, it is likely to be mainly an oil shortage that cannot be made up by other fuels. One consequence of such a shortage would appear in the form of very high prices. As another consequence, the shortage may threaten so many interests that other countries may prevent Korea from procuring at any price more than a fraction of its oil needs.

This is the principal danger that leads Korea to take major steps to reduce reliance on oil: diversifying to coal, nuclear energy, and possibly imported gas while pressing development of solar, tidal and other new sources of energy. If such a severe shortage loomed, Korea would want to press

even harder than before to reduce non-essential energy consumption to a minimum. At such a time, Korea would benefit from all preparations that facilitate continuation of the most important productive activities for export and domestic use, and for residences, transportation and other equipment that used only minimal amounts of energy and relied on fuels that might be available during the oil shortage.

Among the steps that can be taken beforehand are long-term contracts for supply of fuels, especially of coal and uranium, perhaps gas, and possibly accompanied by some stockpiling of uranium ore or enriched fuel against possible interruptions of supply despite long-term contracts. The oil stockpile referred to could, with a severe rationing regime, stretch supply to some nine months, assuming no oil imports whatsoever.

(c) Environment protection policy: As the Korean economy grows, threats to the environment from energy users multiply. Already air pollution is an evident problem in Seoul and to a lesser extent in other cities.

Policy to protect the environment relates to energy policy, but involves many other matters as well. One of the earliest tasks is to evaluate the environmental effects of particular primary commercial fuels, or combinations of them, and then to attempt to define both the economic/social consequences of a government granting priority to one or another and on which income levels the burden falls. Government must also approve and inspect the installation of pollution-abatement measures.

(d) Energy data. Korea needs a range of energy data, reliable and current, for management and policy formulation. It will not do to have competing sources offering different data about the same matters. It is recommended the creation of a Central Energy Statistical Office (CESO), to be located in MER, to serve all users in Korea, both public and private.

(e) Energy research and development: Effective energy policy and efficient energy use require much knowledge and technology that have not yet appeared in Korea, and nowhere else either. Consequently, Korea and other countries must put a large amount of effort into energy R&D.

For the near future what Korea should do will, in many matters, not include basic scientific research. Korea's limited number of qualified personnel in these matters should concentrate on development work, bringing to their country and adapting to its circumstances and needs scientific discoveries and inventions and developments originating elsewhere.

(f) Energy Pricing Policy: Korea has gone far toward energy pricing according to long-run marginal costs. But coal is still heavily subsidized. It is time for all energy prices to conform to the full-cost standard.

(g) Institutions and procedures for effective energy policy. Korea's institutions and procedures for making and carrying out energy policy must reflect Korea's answers to the questions of demand, supply and managemment mentioned in earlier parts of this chapter.

(i) One instrument that should be considered is a review of the energy implications of proposed major policies, programs and projects. Korea needs to know the energy costs and commitments implied by new factories, industrial estates, economic programs, or economic growth policies.

A means of enforcing such reviews would be to require for building permits, operating licenses, a project or a program or a policy, approval of an energy impact statement. Before approving the proposed action, MER (and other concerned institutions) could discuss the accuracy of the statement and the appropriateness of the proposed project, etc., from the point of view of energy, withholding approval from proposals that would commit undue amounts of energy use or inappropriate kinds of energy use, or would have undesirable environmental consequences from the energy consumed.

(ii) The Ministry of Energy and Resources needs to develop into a strong and expert agency, as its leadership is fully aware. But no matter how good MER becomes, much of its work will involve coordination with other ministries, and with business and public organizations. Thus MER needs to develop also a considerable capacity for negotiating with other ministries and official bodies, developing allies and finding ways to persuade reluctant officials, businessmen and others of the necessity of efficient energy use. No law, decree or organization chart will substitute for such skills and steady cooperation with others.

(iii) Preparation of an annual, comprehensive National Energy Audit which depicts progress/failures to meet objectives in conservation, domestic and foreign supply, the GNP/energy growth ratio, etc., and reasons therefore. Such an exercise affords the nation a means of better ensuring energy needs will be met. Many countries attempt such but their efforts lack comprehensiveness and objectivity. In Korea's case, the nation has an opportunity to serve itself through such a rigorous exercise and to set an example for others.

C. Priorities

In summary, to improve upon the Ministry's ability to cope with the requirements of energy policy formulation and implementation, priority should be given to:

1. The training of personnel in all aspects of energy sources - domestic and foreign (coal, oil, gas, etc.) including energy policy and planning, data collection and analysis.

2. The creation of a Central Energy Statistical Office.

3. A reconsideration of energy pricing policies.

4. Strengthening environmental/pollution policies.

5. Creation of an emergency supply program.

6. An Energy Impact Evaluation program to determine if a particular investment meets conservation policies and has the best choice of fuel.

7. A rigorous examination of all the implications in Korea's nuclear planning, including costs, manpower and demands upon "localization", waste disposal and prospects for a full fuel cycle.

8. Strengthening the competence and autonomy of KECO.

9. Attention to limitations on domestic coal and substitutes for residential heating; preparation for increased coal imports.

10. Review of research institutes' strengths and weaknesses: programs, personnel, funding and assimilation of results into energy sectors.

11. Annual preparation of a National Energy Audit.

KOREA

GOJEONG POWER PROJECT

Actual Energy Sales, Generation, Peak Demand, Installed Capacity and Number of Employees

	1961	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
1. Energy Sales by Consumer Category, No. of Consumers and Average Electricity Price											
Energy sales (Gwh)	1,213	6,358	7,740	8,884	9,992	12,367	14,048	16,630	19,620	22,883	27,326
Lighting	228	827	1,009	1,232	1,442	1,727	1,853	2,130	2,461	2,990	3,959
Small power	148	496	572	646	751	1,000	967	1,130	1,811	2,000	5,061
Large power	816	4,999	6,122	6,968	7,752	9,583	11,168	13,286	15,232	17,686	18,116
Agriculture & fishery	21	36	37	38	47	57	60	84	116	157	190
No. of customers	797,252	1,784,102	2,025,170	2,355,618	2,596,912	2,999,105	3,427,693	3,938,820	4,237,294	4,659,279	4,935,155
Lighting	770,785	1,735,381	1,969,618	2,294,138	2,529,678	2,992,637	3,331,538	3,830,969	4,115,432	4,522,127	4,779,259
Small power	24,702	43,833	49,824	54,899	59,951	67,460	84,173	93,588	109,207	120,559	132,998
Large power	1,720	4,749	5,596	6,481	7,151	8,611	11,122	12,258	8,013	9,220	10,580
Agriculture & fishery	45	139	132	100	132	397	860	2,005	4,642	7,393	12,318
Average electricity price (W/Kwh)	2.79	5.86	6.34	6.41	7.36	7.30	10.64	17.10	19.43	21.81	22.38
Lighting	6.00	12.34	13.21	13.16	14.69	14.95	23.64	30.66	32.76	32.88	32.85
Small power	4.27	8.22	9.04	9.05	10.10	7.70	14.78	29.63	32.39	36.21	41.33
Large power	2.21	4.57	4.97	4.99	5.75	5.90	8.15	13.92	15.84	18.42	18.29
Agriculture & fishery	1.53	3.20	3.55	3.54	4.04	4.17	6.03	6.06	6.94	10.02	10.41
2. Generation (Gwh), Peak Demand (MW), Installed Capacity (MW) and No. of Employees											
Energy sales (Gwh)	1,213	6,358	7,740	8,884	9,992	12,367	14,047	16,630	19,620	22,833	27,326
T&D losses (%)	28.0	13.5	11.8	11.4	10.8	11.4	11.7	11.3	10.8	9.3	8.4
Net generation (Gwh)	1,684	7,348	8,780	10,029	11,207	13,956	15,911	18,751	21,991	25,171	29,909
Plant use (%)	5.0	4.6	4.2	4.4	5.3	5.9	5.5	5.5	5.2	5.3	5.1
Gross generation (Gwh)	1,773	7,700	9,168	10,541	11,839	14,826	16,834	19,837	23,116	26,586	31,510
Hydro	652	1,429	1,221	1,320	1,368	1,223	1,493	1,338	1,340	949	1,281
Steam	1,118	5,601	7,546	7,565	8,450	11,102	13,113	15,766	19,021	22,082	23,393
Internal combustion	3	670	360	170	68	51	182	203	246	819	1,981
Nuclear	-	-	-	-	-	-	-	-	-	-	2,324
Power purchased	-	-	41	1,486	1,953	2,450	2,046	2,530	2,509	2,736	2,531
Load factor (%)	66.2	65.6	67.3	67.7	64.3	66.2	65.8	67.6	69.1	72.5	70.3
Peak demand (MW)	306	1,340	1,555	1,777	2,097	2,556	2,922	3,351	3,807	4,187	5,118
Installed capacity (MW)	368	1,636	2,068	2,628	3,872	4,272	4,523	4,720	4,812	5,791	6,916
Hydro	143	327	327	340	340	620	620	620	712	712	712
Steam	223	1,050	1,477	2,024	3,274	3,394	3,645	3,845	3,845	4,154	4,692
Internal combustion	2	259	264	264	258	258	258	255	255	925	925
Nuclear	-	-	-	-	-	-	-	-	-	-	587
Reserve margin (MW)	62	296	513	851	1,775	1,716	1,601	1,369	1,005	1,604	1,798
(%)	20.2	22.0	33.0	48.8	84.6	67.1	54.8	40.9	30.0	38.3	35.3
Consump./capita (Kwh)	45	207	246	279	309	376	420	480	547	627	733
Employees (KECO)	10,095	12,983	12,440	11,940	11,212	11,629	13,092	13,959	14,997	15,930	16,576

KOREA

GOJEONG POWER PROJECT

Forecasted Energy Sales (Gwh), Generation (Gwh), Peak Demand (MW) and Installed Capacity (MW)

	1979	1980	1981	1982	1983	1984	1985	1986
Energy sales (Gwh	31,424	35,980	41,017	46,544	52,594	59,432	66,861	74,844
Lighting	4,502	5,090	5,764	6,556	7,470	8,530	9,541	10,608
Small power	5,775	6,630	7,343	8,185	9,088	10,105	11,189	12,334
Large power	20,962	24,060	27,695	31,562	35,768	40,501	45,805	51,544
Agriculture & fishery	185	200	215	241	268	296	326	358
T&D losses - %	8.7	8.7	8.5	8.3	8.1	7.9	7.7	7.5
- Gwh	2,994	3,429	3,810	4,212	4,636	5,111	5,576	6,068
Net generation (Gwh)	34,418	39,409	44,827	50,756	57,230	64,543	72,437	80,912
Plant use - %	5.2	5.2	5.3	5.5	5.7	5.8	5.9	6.0
- Gwh	1,885	2,162	2,509	2,954	3,459	3,974	4,542	5,165
Gross generation Gwh	36,303	41,571	47,336	53,710	60,689	68,517	76,979	86,077
Load factor (%)	70.5	70.8	71.0	70.9	70.8	70.6	70.3	70.0
Peak demand (MW)	5,879	6,702	7,611	8,648	9,785	11,079	12,500	14,037
Installed capacity (MW)	8,035	9,436	10,406	11,324	13,443	16,338	18,803	21,196
Hydro	712	802	802	802	802	1,147	1,262	1,455
Pumped storage station	200	400	400	400	400	1,000	1,000	1,400
Thermal	6,539	7,647	8,417	9,667	10,535	11,325	11,825	11,825
Nuclear	587	587	587	587	1,916	2,866	4,716	6,516
Retire (-)	-3			-132	-210			
Reserve margin - MW	2,156	2,734	2,795	2,676	3,658	5,259	6,303	7,159
- %	36.7	40.8	36.7	30.9	37.4	47.4	50.4	51.0

ANNEX 4

KOREA

POWER EXPANSION PROGRAM (1979-86)

Generation Facilities

Year/Month		Plant Name	Date of starting (year/mo.)	Added capacity (MW)	Total capacity (MW)
1978	12	Existing facilities			6,916
1979	2	Yeong Weol combine cicle (c/c)	76/07	100	
	4	Gunsan (c/c)	76/07	100	
	6	Hanrim diesel (4 sets)	78/08	10	
	7	Ulsan (c/c)	77/03	100	
	9	Ulreungdo diesel	78/09	2	
	11	Yeong Dong thermal #2	76/08	200	
	11	Cheong Pyeong pumped st. #1	75/09	200	
	12	Namjeju thermal #1	77/06	10	
	12	Ulsan thermal #4	77/04	400	
		Retire		-3	8,035
1980	3	Cheong Pyeong pumped st #2	75/09	200	
	3	Ulreungdo diesel	78/09	1	
	3	Asan thermal #1	76/12	350	
	6	Daecheong hydro	75/03	90	
	6	Namjeju thermal #2	77/06	10	
	9	Asan thermal #2	76/12	350	
	12	Ulsan thermal #5	77/04	400	9,436
1981	6	Ulsan thermal #6	77/04	400	
	9	Jeju gas turbine		20	
	12	Seohae thermal #1	78/10	200	
	12	Asan thermal #5	79/05	350	10,406
1982	3	Asan thermal #6	79/05	350	
	6	Seohae thermal #2	78/10	200	
	8	Samcheonpo thermal #1	78/10	500	
		Retire		-132	11,324
1983	2	Samcheonpo thermal #2	78/10	500	
	4	Weolseong nuclear	76/01	679	
	10	Gojeong thermal #1	79/08	500	
	12	Gori nuclear #2	77/05	650	
		Retire		-210	13,443
1984	4	Gojeong thermal #2	79/08	500	
	6	Samrangjin pumped st.	79/10	600	
	9	Chungju hydro #1, 2, 3	78/06	345	
	9	New nuclear #5	78/01	950	
	12	Asan thermal #3	81/11	500	16,338
1985	4	Chungju hydro #4	78/06	115	
	9	New nuclear #6	78/01	950	
	9	New nuclear #7	79/03	900	
	12	Asan thermal #4	81/11	500	18,803
1986	6	Imha hydro	82/03	50	
	6	Hongcheon hydro	82/03	63	
	9	New nuclear #8	79/03	900	
	9	New nuclear #9	80/04	900	
	12	Habcheon pumped st.	83/03	400	
	12	Habcheon hydro	83/03	80	21,196

KOREA

POWER EXPANSION PROGRAM (1979-86)

Transmission and Distribution Facilities

	Unit	Existing at end of 1978	1979	1980	1981	1982	1983	1984	1985	1986
Transmission lines										
345 KV	C-km	1,143	1,739	2,129	2,799	3,199	3,649	4,009	4,259	4,727
154 KV	C-km	5,124	5,986	6,976	7,700	8,248	8,918	9,638	10,388	11,138
66 KV & below	C-km	4,519	4,538	4,579	4,605	4,674	4,674	4,674	4,674	4,674
Total	C-km	10,786	12,263	13,684	15,104	16,121	17,241	18,321	19,321	20,539
Substations										
345 KV	MVA	2,667	5,167	7,667	8,667	9,667	10,677	12,167	13,167	14,667
154 KV	MVA	6,888	8,828	11,528	13,688	16,008	17,748	19,728	21,968	24,488
66 KV & below	MVA	2,903	3,077	3,179	3,207	3,324	3,324	3,324	3,324	3,324
Total	MVA	12,458	17,072	22,374	25,562	28,999	31,739	35,219	38,459	42,479
Distribution network										
Line length	km	108,074	111,794	115,454	119,534	123,774	128,204	132,864	137,774	142,904
Pole transformers	MVA	4,702	5,312	6,002	6,772	7,632	8,582	9,632	10,792	12,062

ANNEX 6

KOREA

GOJEONG POWER PROJECT

KOREA ELECTRIC COMPANY (KECO)

Estimated Cost of the Project /a

	Local	Foreign	Total	Local	Foreign	Total
	----- (W million) -----			------ (US$'000) -------		
1. Gojeong Power Station						
Structures & improvements	26,255	-	26,255	54,135	-	54,135
Boiler plant equipment	54,298	37,665	91,963	111,954	77,659	189,613
Turbine generator units	11,052	20,672	31,724	22,788	42,623	65,411
Accessory electric equip.	5,006	3,862	8,868	10,321	7,963	18,284
Misc. power plant equip.	311	931	1,242	642	1,920	2,562
Substation equipment	77	3,938	4,015	160	8,119	8,279
Communication equipment	25	92	117	52	190	242
Other	36,954	3,641	40,595	76,194	7,507	83,701
Land	1,513	-	1,513	3,120	-	3,120
Engineering services	10,175	-	10,175	20,979	-	20,979
Base Cost	145,666	70,801	216,467	300,345	145,981	446,326
Contingencies						
Physical	11,535	3,976	15,511	23,783	8,197	31,980
Price	35,967	13,690	49,657	74,159	28,226	102,385
Total	193,168	88,467	281,635	398,287	182,404	580,691
2. Transmission System						
Right-of-way	134	-	134	277	-	277
Towers	6,431	-	6,431	13,260	-	13,260
Conductors	6,477	-	6,477	13,354	-	13,354
Insulators	-	1,125	1,125	-	2,320	2,320
Hardware	-	1,525	1,525	-	3,144	3,144
Other	275	-	275	568	-	568
Equipment for S/S	587	406	993	1,210	836	2,046
Civil works	6,171	-	6,171	12,723	-	12,723
Engineering & adminis.	1,520	-	1,520	3,135	-	3,135
Base Cost	21,595	3,056	24,651	44,527	6,300	50,827
Contingencies						
Physical	2,160	306	2,466	4,453	630	5,083
Price	8,797	1,142	9,576	17,377	2,354	19,731
Total	32,183	4,504	36,687	66,357	9,284	75,641
3. Management Consultants	73	291	364	150	600	750
Contingencies	26	95	121	53	196	249
Total	99	386	485	203	796	999
4. GRAND TOTAL	225,450	93,357	318,807	464,847	192,484	657,331

/a Excluding custom duties, taxes and interest during construction.

KOREA

GOJEONG POWER PROJECT

KOREA ELECTRIC COMPANY (KECO)

Annual Expenditures
Local Costs (10^3 US$)

	1979	1980	1981	1982	1983	1984	Total
Gojeong Power Station							
Structures & improvements	5,413	22,574	18,352	5,035	2,165	596	54,135
Boiler plant equipment	11,195	16,569	36,161	33,474	13,323	1,232	111,954
Turbine-generator units	1,276	3,418	7,975	7,292	2,142	685	22,788
Accessory electric equip.	-	1,961	5,160	2,167	1,033	-	10,321
Misc. power plant equip.	-	32	109	304	141	58	642
Substation equipment	-	16	32	64	32	16	160
Communication equipment	-	5	11	21	10	5	52
Other	3 807	15,238	26,667	19,051	7,619	3,812	76,194
Land	3,120	-			-	-	3,120
Engineering services	1,049	5,245	5,245	5,245	3,146	1,049	20,979
Subtotal	25,860	65,058	99,712	72,651	29,611	7,453	300,345
Contingency - Physical	1,992	5,582	7,933	5,383	2,233	660	23,783
- Price	2,103	10,438	23,561	21,909	11,791	4,537	74,159
Total	29,955	81,078	131,206	99,943	43,635	12,470	398,287
Transmission System							
Right-of-way	-	227	-	-	-	-	277
Towers	-	-	2,651	9,281	1,328	-	13,260
Conductors	-	-	2,671	9,348	1,335	-	13,354
Other	-	-	-	454	114	-	568
Equipment for substations	-	-	424	665	121	-	1,210
Civil works	-	-	4,416	6,941	1,366	-	12,723
Engineering & Admin.	-	-	1,097	1,724	314	-	3,135
Subtotal	-	227	11,259	28,413	4,578	-	44,527
Contingency - Physical	-	28	1,126	2,841	458	-	4,453
- Price	-	52	3,344	11,564	2,417	-	17,377
Total	-	357	15,729	42,818	7,453	-	66,357
Management Consultants	-	67	83	-	-	-	150
Contingency - Physical	-	7	8	-	-	-	15
- Price	-	13	25	-	-	-	38
Total	-	87	116			-	203
GRAND TOTAL	29,955	81,522	147,051	142,761	51,088	12,470	464,847

KOREA

GOJEONG POWER PROJECT

KOREA ELECTRIC COMPANY (KECO)

Annual Expenditures
Foreign Cost (10^3 US$)

	1979	1980	1981	1982	1983	1984	Total
Gojeong Power Station							
Boiler plant equipment	3,883	7,766	31,064	19,415	11,649	3,882	77,659
Turbine-generator units	2,131	2,131	12,787	17,049	6,393	2,132	42,623
Accessory electric equip.	-	796	2,389	3,982	796	-	7,963
Misc. power plant equip.	-	-	672	1,056	192	-	1,920
Substation equipment	-	-	812	4,871	2,436	-	8,119
Communication equipment	-	-	20	133	37		190
Other	-	832	2,176	3,264	1,235	-	7,507
Subtotal	6,014	11,525	49,920	49,770	22,738	6,014	145,981
Contingency - Physical	123	1,153	2,593	2,030	1,697	601	8,197
- Price	68	1,902	7,132	7,592	8,026	3,506	28,226
Total	6,205	14,580	59,645	59,392	32,461	10,121	182,404
Transmission System							
Insulators	-	-	464	1,426	430	-	2,320
Hardware	-	-	630	1,884	630	-	3,144
Equipment for substations	-	-	167	502	167	-	836
Subtotal	-	-	1,261	3,812	1,227	-	6,300
Contingency- Physical	-	-	126	381	123	-	630
- Price	-	-	347	1,426	581	-	2,354
Total	-	-	1,734	5,619	1,931	-	9,284
Management Consultants	-	270	330	-	-	-	600
Contingency - Physical	-	27	33	-	-	-	60
- Price	-	45	91	-	-	-	136
Total	-	342	454	-	-	-	796
GRAND TOTAL	6,205	14,922	61,833	65,011	34,392	10,121	192,484

ANNEX 8

KOREA

GOJEONG POWER PROJECT

Loan Disbursement Schedule
(US$ millions)

Assumptions

Effective Date: April 1980
Closing Date : December 1984

IBRD Fiscal Year and semester	Disbursements during semesters	Cumulative disbursements at end of semester
1980/1981		
June 30, 1980	-	-
December 31, 1980	3.0	3.0
1981/1982		
June 30, 1981	18.0	21.0
December 31, 1981	22.0	43.0
1982/1983		
June 30, 1982	24.9	67.9
December 31, 1982	24.0	91.9
1983/1984		
June 30, 1983	11.1	103.0
December 31, 1983	8.0	111.0
1984/1985		
June 30, 1984	2.5	113.5
December 31, 1984	1.5	115.0

KOREA

KOREA ELECTRIC COMPANY (KECO)

Actual and Forecast Income Statements (1974-86)
(in billions of won)

Fiscal Year Ended December 31	Actual					Forecast							
	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Sales of electricity (GWH)	14,048	16,630	19,620	22,833	27,326	31,200	35,980	41,017	46,544	52,594	59,432	66,861	74,844
Increase over previous year (%)	13.6	18.4	18.0	16.4	19.7	14.2	14.5	14.0	13.5	13.0	13.0	12.5	12.0
Average revenue per KWH sold (won)	10.61	17.20	19.57	22.03	22.40	30.00	36.19	40.50	43.21	46.01	48.93	52.57	56.00
Average revenue per KWH (US cents)	2.19	3.55	4.04	4.54	4.62	6.39	7.46	8.35	8.91	9.49	10.09	10.84	11.55
Operating Revenues													
Revenue from electrity sales	149	286	384	503	612	936	1,302	1,661	2,011	2,420	2,908	3,515	4,191
Other operating revenues	1	1	2	3	2	4	6	8	10	12	14	16	18
Total Operating Revenues	150	287	386	506	614	940	1,308	1,669	2,021	2,432	2,922	3,531	4,209
Operating Expenses													
Fuel	82	156	195	236	283	439	561	682	826	927	1,020	1,171	1,305
Purchased power	20	29	33	36	36	43	49	53	53	52	61	77	81
Personnel expenses	15	22	28	47	62	88	110	143	126	148	174	204	239
Maintenance & other expenses	12	19	27	33	52	94	116	151	189	236	310	390	501
Depreciation	17	23	50	55	68	106	147	192	247	338	456	603	788
Taxes	-	2	3	9	7	13	20	23	26	29	34	39	41
Total Operation Revenues	146	251	336	416	508	783	1,003	1,244	1,467	1,730	2,055	2,484	2,955
Operating income	4	36	50	90	106	157	305	425	554	702	867	1,047	1,254
Non-operating income (net)	21	2	3	3	1	1	1	1	1	1	1	1	1
Interest Expense													
Gross interest	27	36	41	49	74	159	251	377	517	617	738	847	944
Less interest charged to construction	(7)	(12)	(16)	(24)	(31)	(76)	(138)	(177)	(233)	(259)	(283)	(318)	(257)
Net interest	20	24	25	25	43	83	113	200	284	358	455	529	687
Net Income	5	14	28	68	64	75	193	226	271	345	413	519	568
Rate of Return (%)													
On average net fixed assets and working capital plus 100% of of average work-in-progress	0.7	4.8	5.2	7.4	6.7	6.8	9.0	9.0	9.0	9.0	9.0	9.0	9.0

KOREA

KOREA ELECTRIC COMPANY (KECO)

Actual and Forecast Balance Sheets (1974-86)
(in billions of won)

As of December 31	Actual					Forecast							
	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
ASSETS													
Fixed Assets													
Gross fixed assets in service	518	699	973	1,142	1,429	2,354	3,189	4,069	5,243	7,473	9,701	12,996	16,690
Less accumulated depreciation	(115)	(158)	(360)	(412)	(469)	(724)	(943)	(1,229)	(1,599)	(2,097)	(2,763)	(3,642)	(4,794)
Net fixed assets in service	403	541	613	730	960	1,630	2,246	2,840	3,644	5,376	6,938	9,354	11,896
Work in progress	132	181	297	472	643	952	1,584	2,313	2,968	2,943	3,195	2,758	2,620
Total Fixed Assets	535	722	910	1,202	1,603	2,582	3,830	5,153	6,612	8,319	10,133	12,112	14,516
Nuclear fuel	-	-	-	-	-	19	26	31	35	72	126	209	326
Current Assets													
Cash	5	12	25	26	25	22	(4)	34	37	45	63	143	143
Customers receivables	15	25	39	39	56	82	109	138	168	202	242	293	349
Inventories	26	34	37	52	68	95	105	114	124	134	148	162	178
Other current assets	14	19	47	45	44	75	179	197	217	239	262	290	318
Total Current Assets	60	90	148	162	193	274	389	483	546	620	715	888	988
Deferred & Other Assets	63	24	28	38	59	65	71	76	82	88	94	101	108
Total Assets	658	836	1,086	1,402	1,855	2,940	4,316	5,743	7,275	9,099	11,068	13,310	15,938
LIABILITIES													
Equity													
Capital	93	165	331	399	429	458	508	558	608	658	708	758	808
Dividends due to Govt	16	19	20	20	69	69	69	69	69	69	69	69	69
Revaluation reserve	38	61	62	62	62	341	504	729	1,013	1,377	1,914	2,608	3,544
Retained earnings	12	21	39	80	77	133	321	544	815	1,160	1,573	2,092	2,660
Total Equity	159	266	452	561	637	1,001	1,402	1,900	2,505	3,264	4,264	5,527	7,081
Long-term Debt													
Gross long-term debt	417	482	540	719	1,045	1,745	2,703	3,614	4,522	5,569	6,517	7,474	8,523
Less current maturities	(51)	(61)	(61)	(77)	(114)	(142)	(249)	(392)	(553)	(652)	(843)	(951)	(1,050)
Net long-term debt	366	421	479	642	931	1,603	2,454	3,222	3,969	4,917	5,674	6,523	7,473
Current Liabilities													
Amounts payable	37	35	29	46	60	67	73	79	86	92	100	107	116
Current maturities	51	61	61	77	114	142	249	392	553	652	843	951	1,050
Other liabilities	26	29	32	36	58	65	71	77	83	89	96	104	112
Total Current Liabilities	114	125	122	159	232	274	393	548	722	833	1,039	1,162	1,278
Other Liabilities	19	24	33	40	55	62	67	73	79	85	91	98	106
Total Liabilities	658	836	1,086	1,402	1,855	2,940	4,316	5,743	7,275	9,099	11,068	13,310	15,938
Debt/Equity Ratios	70/30	61/39	51/49	53/47	59/41	62/38	64/36	63/37	61/39	60/40	57/43	54/46	51/49

ANNEX 11

KOREA

KOREA ELECTRIC COMPANY (KECO)

Sources and Applications of Funds (1974-86)
(in billions of won)

Fiscal Year Ended December 31	Actual					Forecast							
	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
SOURCES OF FUNDS													
Internal Sources													
Operating & other income	25	38	53	93	107	158	306	426	555	703	868	1,048	1,255
Consumers contributions	1	10	33	17	25	16	16	17	22	22	23	24	25
Depreciation & amortization	17	23	50	55	68	110	160	207	261	359	501	674	899
Less dividends	(5)	(5)	(9)	(25)	(19)	(19)	(5)	(3)					
Total Internal Sources	38	66	127	140	181	265	477	647	838	1,084	1,392	1,746	2,179
External Sources													
Equity	8	35	105	68	30	29	50	50	50	50	50	50	50
Borrowing	85	123	158	234	381	800	1,100	1,160	1,300	1,600	1,600	1,800	2,000
Total Sources of Funds	131	224	390	442	592	1,094	1,627	1,857	2,188	2,734	3,042	3,596	4,229
APPLICATIONS OF FUNDS													
Capital Expenditures (incl. interest charged to construction)	95	122	219	370	485	845	1,268	1,327	1,462	1,761	1,855	2,066	2,509
Debt Service													
Principal payments	38	51	97	60	77	100	142	249	392	553	652	843	951
Gross interest	27	36	41	49	74	159	251	377	517	617	738	847	944
Gross debt service	65	87	138	109	151	259	393	626	909	1,170	1,390	1,690	1,895
Less interest charged to construction	(7)	(12)	(16)	(24)	(31)	(76)	(138)	(177)	(233)	(259)	(283)	(318)	(257)
Net debt service	58	75	122	85	120	183	255	449	676	911	1,107	1,372	1,638
Change in Working Capital	(10)	28	61	(7)	(6)	67	103	82	50	62	80	158	83
Change in Other Assets & Libilities	(12)	(1)	(12)	(6)	(7)	(1)	1	(1)	-	-	-	-	(1)
Total Applications of Funds	131	224	390	442	592	1,094	1,627	1,857	2,188	2,734	3,042	3,596	4,229
Debt service coverage	0.7	0.9	1.0	1.6	1.5	1.4	1.9	1.4	1.4	1.2	1.3	1.3	1.3
% Contribution to investment	NIL	NIL	NIL	15	13	14	16	14	11	9	15	17	21

KOREA

GOJEONG POWER PROJECT

Assumptions Adopted for Financial Forecasts

The following assumptions were adopted when preparing KECO's financial forecasts:

(a) Income Statements

(i) Electricity Sales are based on KECO's March 1979 "Long-Range Power Development and Financial Plan" with allowance for some reduced growth as a result of energy conservation measures taken in June 1979 (para. 3.07).

(ii) Operating Revenues have been obtained by assuming electricity rates will be increased each year so as to earn a rate of return on average net fixed assets, working capital and 100% of work-in-progress of 9%.

(iii) Fuel. KECO's constant price estimates have been increased 6% per annum through 1986 except in 1979 when prices were assumed to have been increased 50% during the second half of the year, following large increases in international oil prices in the first half of the year.

(iv) Purchased power costs are based on KECO's constant price estimates (March 1979 Plan) of purchases escalated according to estimates of domestic inflation in Korea of 1979 14% first half of the year and 10% for the second half; 1980 9% and 1981-86 8%.

(v) Personnel Expenses (including Accrued Retirement) costs are based on KECO's constant price estimates (March 1979 Plan) and have been escalated according to estimates of domestic inflation in Korea (previously mentioned - see Purchased Power). Number of employees, excluding construction staff assumed by KECO for each year are as follows:

1979	15,058
1980	15,936
1981	16,754
1982	17,516
1983	18,266
1984	19,036
1985	19,972
1986	21,029

(vi) Maintenance and Other Expenses have been escalated using estimated domestic inflation in Korea (para. 4 Purchased Power).

(vii) Depreciation Expense calculations have been based on KECO's existing depreciation rates i.e.: assuming an average life of 18 years. Additions have been depreciated at half rates in the year in which they are first taken up as part of assets in service.

(viii) Tax calculations assume the existing defense tax which is 10% of net income will be retained during the period of the forecasts.

(ix) Interest Expense has been based on the average rate of interest used by KECO for its financial plan plus escalation of about 2% p.a. The rates actually used for the forecasts were:

1979	11.41%
1980	11.28%
1981	11.93%
1982	12.72%
1983	12.23%
1984	12.22%
1985	12.11%
1986	11.80%

The above rates were applied to the average value for outstanding long-term debt in each respective year.

(x) Interest Charged to Construction. Based on KECO's financial plan but escalated 2% p.a.

(b) Balance Sheet

(i) Gross Fixed Assets in Service, Accumulated Depreciation have been revalued in 1977, 9.3% and in 1978 11.3% in accordance with the Korea Wholesale Price Index for all commodities. In 1979 gross fixed assets and accumulated depreciation were revalued 12% and thereafter at 10% annually.

(ii) Nuclear fuel is shown as a fixed asset item. It is amortized over three years.

(iii) Current Assets

- Customers' Receivables represent one month's sales.

- Inventories have been based on KECO's financial plan estimates and then escalated at the same rate as fuel costs (Item (a) (iii).

- Other Current Assets have been escalated by 12% for 1979, 9% for 1980 and 8% thereafter through 1986.

(iv) Deferred and other assets were escalated in accordance with the same rates as were used for Other Current Assets (b)(iii).

(v) Capital was increased in accordance with KECO's financial plan W 29 billion in 1977 and W 50 billion thereafter through 1986.

(vi) Revaluation Reserve includes the amounts for revaluation of gross fixed assets and accumulated depreciation.

(vii) Accounts Payable/Other Liabilities were escalated in accordance with the same rates as were used for "Other Current Assets" (b)(iii).

KOREA

GOJEONG POWER PROJECT

Rate of Return on Investments

Main Assumptions

Exchange Rate

Official	January 1, 1979 - US$1 = W485	
Shadow rate	January 1, 1979 - US$1 = W545	

Conversion Factors

Standard conversion factor	- 0.89	Skilled labor - 1.00
Construction conversion factor	- 0.89	Semi-skilled labor - 0.90
Investment (consumption) conversion factor	- 0.87	Unskilled labor - 0.86
Electricity conversion factor	- 0.89	

Investment costs

Gojeong thermal power plant	- US$478.3 M (1/1/79) - US$442.3 M border price
345 Kv transmission facilities	- US$55.9 M (1/1/79) - US$50.2 M border price
Required distribution capacity	- 475 MVA
Incremental distribution network	- US$170/kVA base price
Investment in distribution	- US$80.8 M (1/1/79) - US$71.5 M border price

Operational cost factor

Fuel	- imported bituminous coal
Price c.i.f.	- US$36.00 tons - US$5.90/10^6 Kcal
Partial load - heat rate	- 2,499 Kcal/Kwh
Incremental heat rate	- 2,160 Kcal/Kwh
Full load - heat rate	- 2,279 Kcal/Kwh
Average fuel cost	- US$13,590/Gwh

Operation & maintenance

Generation (US$1.12/Kw-month)	- US$13.4 M (1/1/79) - US$12.1 M border price
Transmission (US$0.36/Kw-month)	- US$830 GWh (1/1/79) - US$738 GWh border price
Ave. annual transmission cost	- US$3.9 M (1/1/79) - US$3.5 M border price

Distribution network - US$1,892/Gwh (1/1/79) - US$1,683/Gwh border price
billing - US$917/Gwh (1/1/79) - US$807/Gwh border price
others - US$982/Gwh (1/1/79) - US$874/Gwh border price

Average annual cost - US$16.37 M (1/1/79) - US$14.5 M border price

Revenues

Average power tariffs - W 27.27/Kwh (1/1/79) +10% added value tax
- US$61,849/Gwh (1/1/79) - US$55,046/Gwh border price

Sales - Annual estimated sales are indicated in Annex 14

ANNEX 14

KOREA

GOJEONG POWER PROJECT

Incremental Energy Sales (Gwh)

Year	Capacity factor (%)	Net generation (Gwh)	T&D losses (Gwh)	Sales (Gwh)
1983	18.7	784	67	717
1984	63.8	5,343	459	4,884
1985	73.8	6,174	530	5,644
1986	71.5	5,980	516	5,464
1987	70.2	5,872	504	5,368
1988	67.2	5,622	484	5,138
1989	63.4	5,304	456	4,848
1990	62.2	5,204	448	4,756
1991	58.2	4,868	418	4,450
1992	57.1	4,776	410	4,366
1993	55.7	4,660	400	4,260
1994	53.0	4,434	382	4,052
1995	50.5	4,224	364	3,860
1996	49.9	4,174	358	3,816
1997	49.3	4,124	354	3,770
1998	50.1	4,192	360	3,832
1999	52.1	4,358	374	3,984
2000	52.4	4.384	378	4,006
2001	53.0	4,434	382	4,052
2002	52.4	3,484	378	4,006
2003	51.8	4,334	372	3,962
2004	51.2	4,284	368	3,916
2005	50.6	4,352	374	3,978
2006	50.0	4,182	360	3,822
2007	49.4	4,132	356	3,776
2008	48.9	4,100	353	3,747

ANNEX 15

KOREA

GOJEONG POWER PROJECT

KOREA ELECTRIC COMPANY (KECO)

Cost and Benefit Streams for Internal Rate of Return Calculations
(in US$ million)

	Investment costs				Operation & maintenance					Benefits		
Year	Genera-tion	Trans-mission	Distri-bution	Total	Gener-tion	Trans-mission	Distri-bution	Fuel	Total cost	Energy sales (Gwh)	Distribu-tion sales	Net benefits
1979	31.6			31.6					31.6			-31.6 /a
1980	78.6	0.3		78.9					78.9			-78.9
1981	148.1	12.4	10.7	171.2					171.2			-171.2
1982	121.6	31.8	25.0	178.4					178.4			-178.4
1983	49.2	5.7	28.6	83.5					83.5			-83.5
1984	13.2		7.2	20.4	12.1	3.5	14.5	72.6	93.0	4,884	268.8	175.8
1985					12.1	3.5	14.5	83.9	114.0	5,644	310.7	196.7
1986					12.1	3.5	14.5	81.3	111.4	5,464	300.8	189.4
1987					12.1	3.5	14.5	79.8	109.9	5,368	295.5	185.6
1988					12.1	3.5	14.5	76.4	106.5	5,138	282.8	176.3
1989					12.1	3.5	14.5	72.1	102.2	4,848	266.7	164.5
1990					12.1	3.5	14.5	70.7	100.8	4,756	261.8	161.0
1991					12.1	3.5	14.5	66.2	96.3	4,450	245.0	148.7
1992					12.1	3.5	14.5	64.9	95.0	4,366	240.3	145.3
1993					12.1	3.5	14.5	63.3	93.4	4,260	234.5	141.1
1994					12.1	3.5	14.5	60.3	90.4	4,052	223.1	132.7
1995					12.1	3.5	14.5	57.4	87.5	3,860	212.5	125.0
1996					12.1	3.5	14.5	56.7	86.8	3,816	210.1	123.3
1997					12.1	3.5	14.5	56.1	86.2	3,770	207.5	121.3
1998					12.1	3.5	14.5	57.0	87.1	3,832	210.9	123.8
1999					12.1	3.5	14.5	59.2	89.3	3,984	217.3	128.0
2000					12.1	3.5	14.5	59.6	89.7	4,006	220.5	130.8
2001					12.1	3.5	14.5	60.3	90.4	4,052	223.1	132.7
2002					12.1	3.5	14.5	59.6	89.7	4,006	220.5	130.8
2003					12.1	3.5	14.5	58.9	89.0	3,962	218.1	129.1
2004					12.1	3.5	14.5	58.2	88.3	3,916	215.6	127.3
2005					12.1	3.5	14.5	59.4	89.5	3,978	219.0	129.5
2006					12.1	3.5	14.5	56.8	86.9	3,822	210.4	123.5
2007					12.1	3.5	14.5	56.2	86.3	3,776	207.9	121.6
2008					12.1	3.5	14.5	56.0	86.1	3,747	206.3	120.2

Rate of Return: 21.5%

/a () negative.

ANNEX 16

KOREA

GOJEONG POWER PROJECT

Related Documents and Data Available in the Project File

A. General Reports and Documents Related to the Sector and the Borrower

1. KECO Annual Reports 1976-79
2. Growth and Prospects of the Korean Economy, Annex E, Energy, IBRD Report No. 1489-KO, February 23, 1977
3. Considerations Affecting Korea's Energy Objectives, Policies and Strategy, UNDP/IBRD, (Final Draft Report, June 1979)
4. Power Generating Development Plan (1979-86)
5. Long Range Power Development and Financial Plan (March 1979)
6. KECO's Financial and Operating Report 1973-78
7. KECO's Audited Financial Statements, 1974-78

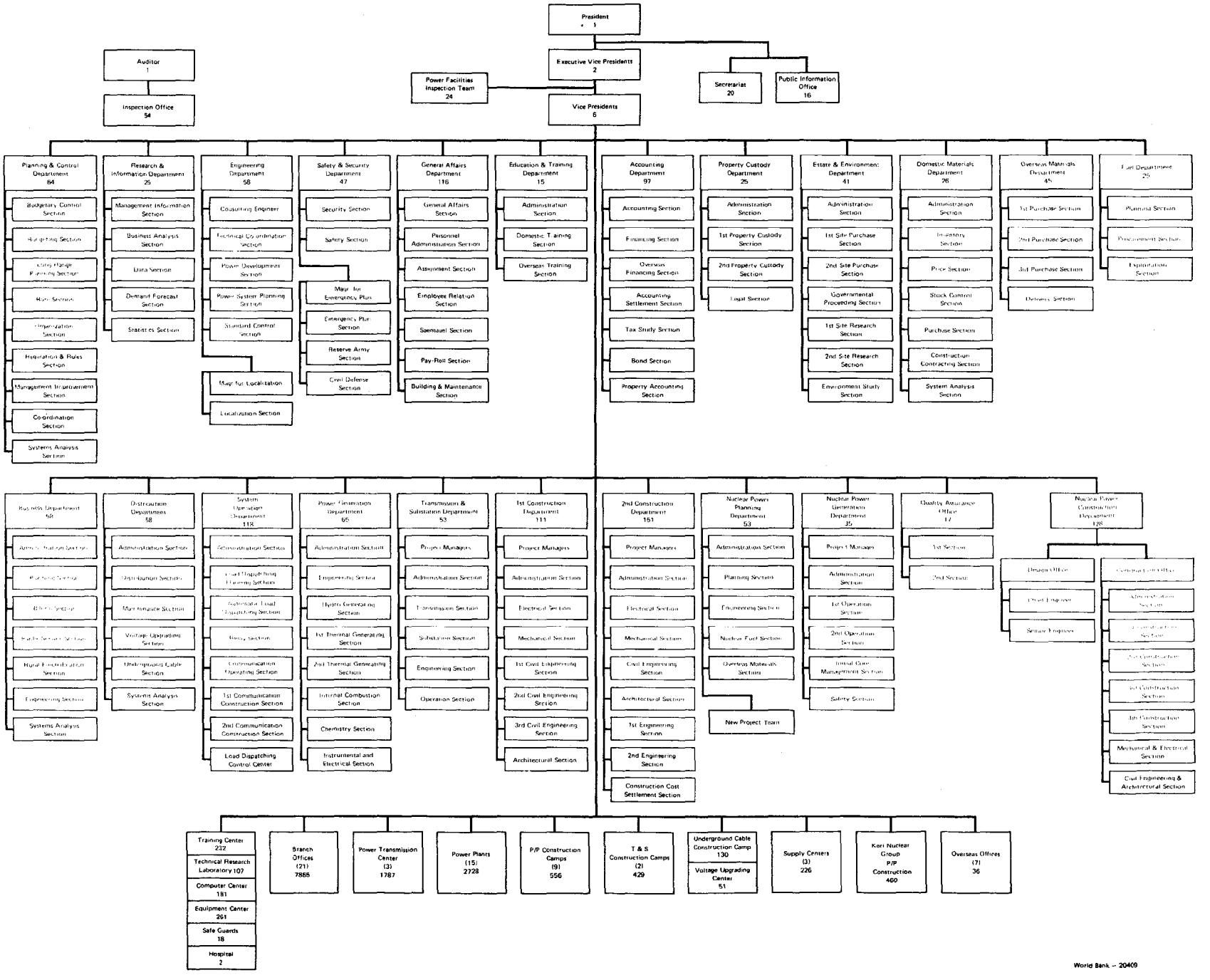
B. General Reports and Documents Related to the Project

1. Feasibility Study for Gojeong Units 1 and 2, Volumes I and II by Overseas Bechtel Inc. and Bechtel International Inc. in Association with Taichan Engineering Co., Ltd., January 1979
2. Report of Geological Investigation for Gojeong Power Electric Generation Plant, October 1978, by Sambo Geologic Co., Ltd.
3. Research Report, Marine Biological Study for Gojeong Power Plant Site by Ocean Research and Development Institute, Korea Institute of Science and Technology, November 1978
4. Report on Ocean Survey for Gojeong Thermal Power Plant by Korea Ocean Science & Engineering Corp., September 1978
5. KECO IBRD Loan Data

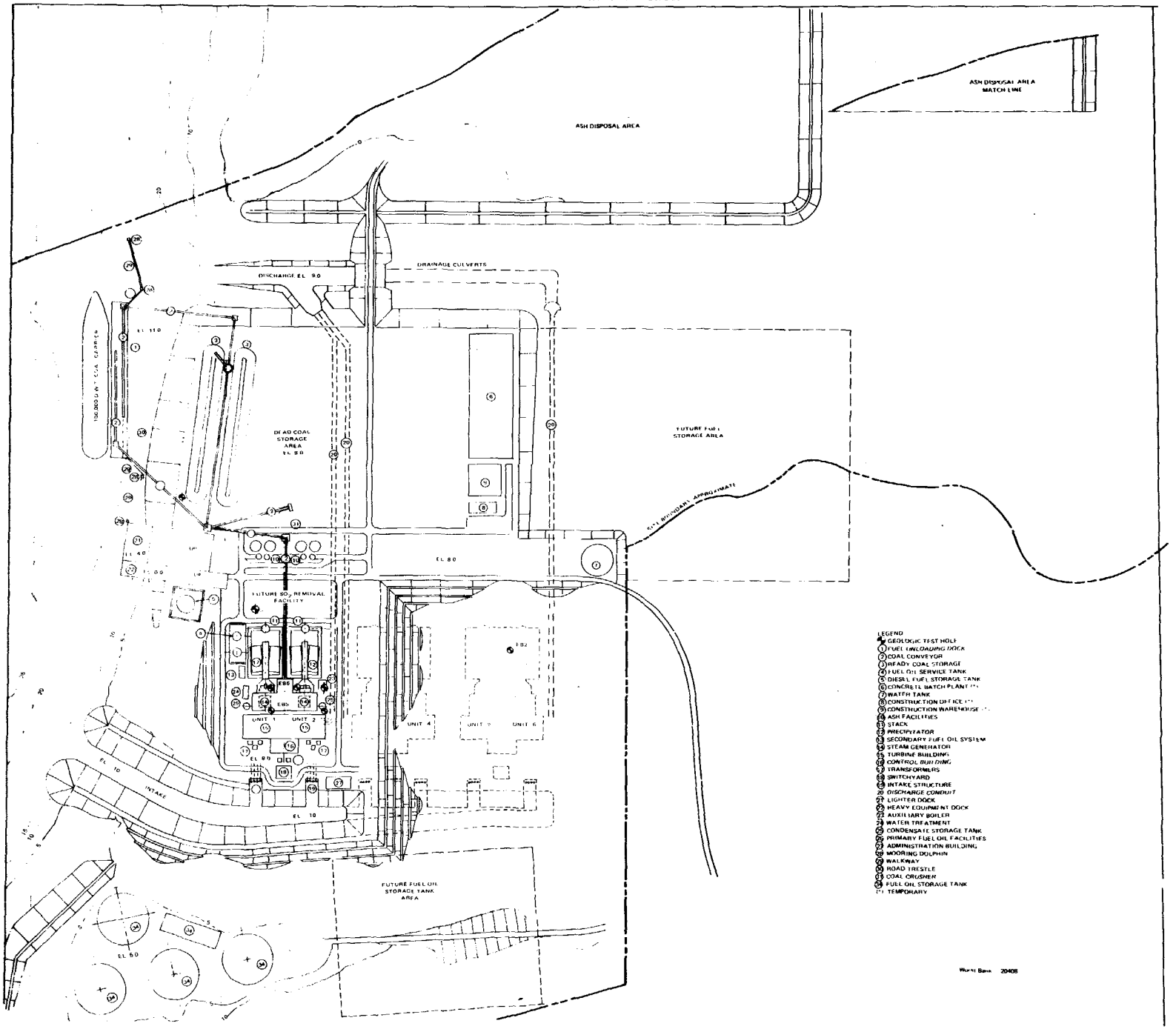
C. Appraisal Working Papers

1. Worksheets for Cost Estimates
2. Worksheets for IERR Calculation and Sensitivity Analysis

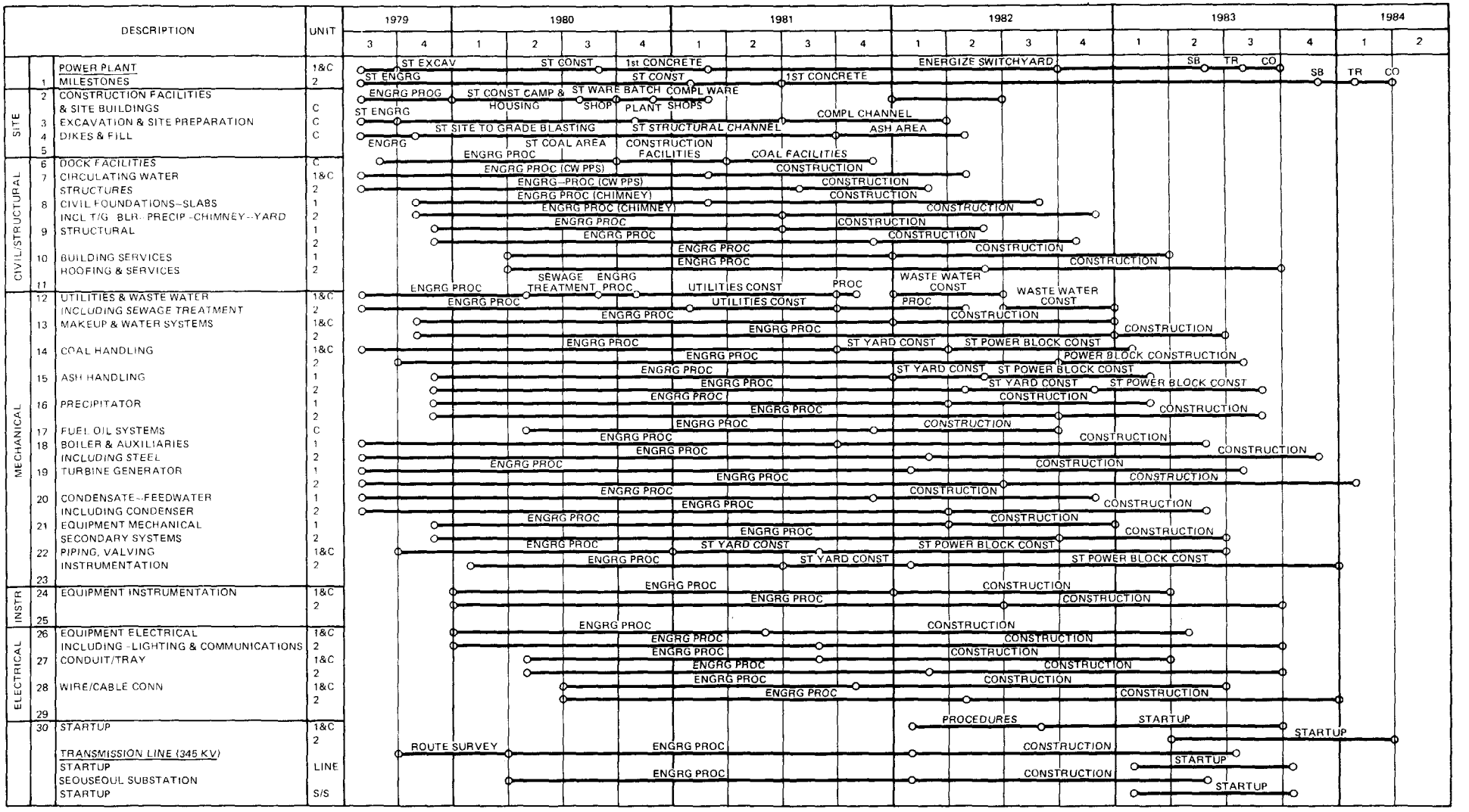
KOREA ELECTRIC COMPANY (KECO)
ORGANIZATION CHART



KOREA
GOJEONG THERMAL POWER PROJECT
TWO-UNIT (500 MW EACH) - SITE LAYOUT



KOREA
GOJEONG THERMAL POWER PROJECT
ESTIMATED CONSTRUCTION SCHEDULE



ABBREVIATIONS

C	= COMMON	EXCAV	= EXCAVATION
CO	= COMMERCIAL OPERATION	SS	= STEAM BLOWS
CONST	= CONSTRUCTION	ST. COMPL	= START, COMPLETE
CW PPS	= CIRCULATING WATER PUMPS	T/G	= TURBINE GENERATOR
ENGRG--PROC	= ENGINEERING, PROCUREMENT	TR	= TURBINE ROLL

World Bank – 20410

IBRD 11320 R

JUNE 1979